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REVISION OF THE BURSERACEAE OF THE MALAYSIAN AREA IN A WIDER SENSE

Xa. CANARIUM Stickm. ¹)

by

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INTRODUCTORY NOTES

1. History and scope

The scope of the present paper is primarily to give a taxonomical revision of the genus *Canarium.* Furthermore, attention has been paid to some subjects of a more general nature, mainly regarding morphology and geography, without, however, claiming completeness.

The last complete revision of the genus was published by Engler in 1883 (in DC. Mon. Phan. 4, 101—151). Of course this is now for the greater part out of date. The later revisions by the same author in E. & P., Nat. Pfl. Fam. ed. 1, 3^4, 1896, 238—242, and ed. 2, 19a, 1931, 443—450, are not really monographs; moreover, they lost in value by the introduction of a subdivision which was mainly based upon unessential characters.

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¹) I—IV in Blumea 7, 1952, 154—170; V—VI in Blumea 7, 1953, 413—472; Va in Blumea 8, 1955, 175—180; VIa and VII—IX in Blumea 7, 1954, 498—552; X in Bish. Mus. Bull. no. 216, 1955, 1—53.

Of fundamental importance for the knowledge of the present genus — though they are chiefly restricted to its Malaysian representatives — are the papers by H. J. Lam on its morphology (Ann. Jard. Bot. Btzg 42, 1931—32, 23—56 & 97—226, t. 5—7 & 11—16) and taxonomy (Bull. Jard. Bot. Btzg III, 12, 1932, 422—534). The present monograph is to be considered an extension and amplification of these works.

2. General part

The revision proper is preceded by a general part which consists of three chapters. It was accepted as a guiding principle, both in this general part as a whole and in the various chapters, first to state the facts and only afterwards to present their interpretation, making a clear distinction between the two. This is why the chapters on morphology and geography precede that on taxonomy.

a. MORPHOLOGY. The chapter on morphology is rather fragmentary. Lam already paid much attention to this subject, of which he made a very detailed study, partly on living material. I mainly restricted myself to some amplifications and some critical notes based on new material which occasionally led to slightly different views.

b. GEOGRAPHY. Lam did not pay much attention to the geographical details within the genus, which he only considered in connection with the supposed phylogeny of the family as a whole. Since, however, *Canarium* presents some striking illustrations of more or less well-known phytogeographical patterns, I gave a rather extensive and detailed account of this subject.

c. COMPARATIVE TAXONOMY. The purpose of the third chapter is to try and arrive at an overall picture, based on points stated in the two foregoing chapters as well as in the special part, thus making an attempt to describe the genus as a living entity with a history of its own. This chapter is consequently of a much more speculative nature than the other ones.

A *conspectus specierum* can be found at the end of the general part.

3. Special part

a. KEYS. The keys are made as clear as possible, both by being concise and by using primarily strictly differential characters. The first of these two points necessitates to compare the specimens with the descriptions. The consequence of the second point is that it may in most cases prove to be hard or even impossible to identify any random incomplete specimen, but it is expected that the key will appear to be a trustworthy guide to come to the name of a species of which complete material is at hand (for incomplete material may be referred to the key in Fl. Mal. I, 5, 1956, 251 as to Malaysian species; for specimens from other regions the chapter on geography may be of some help).

Though it appeared to be difficult to give an efficient key to the sections, complete keys for the species of each section are given, since after some experience it is usually quite easy to recognize the sections.

b. Synonymy. The synonymy is complete as far as possible. Infraspecific taxa have been mentioned only under the publication in which they were first distinguished.

c. Literature. The literature cited is a selection of the more important publications only.

d. Specimens. The specimens are cited geographically, and within each area alphabetically according to the collectors' names. In case of the serial numbers, however, under which the collections made on behalf of some institutes and services have been distributed, priority has been given to these over the names and numbers of the individual collectors. These series are:

BS. — Bureau of Science, Manila
BSIP. — British Solomon Islands Protectorate
BW. — Boswezen, Manokwari
FB. — Forestry Bureau, Manila
FRI. — Forest Research Institute, Bogor
KEP. — Conservator of Forests, Kepong
NBFD. — North Borneo Forest Department, Sandakan
NGF. — New Guinea Forestry, Lae
PNH. — Philippine National Herbarium, Manila
Service forestier de Madagascar
SF. — Singapore Fieldnumbers

Unnumbered specimens have been omitted with a few exceptions; in such cases the number of the herbarium sheet is recorded if any was given.

Except in the case of type specimens, I have refrained from mentioning all herbaria from which I examined specimens of a given number, since I have practically seen and labelled all specimens, up to about 1954 present in the following herbaria (the abbreviations are those proposed by Lanjouw & Stafleu, Ind. Herb. 1, ed. 3, 1956):

A, B, BISH, BK, BLAT, BM, BO, BR, BRI, BRSL, CAL, DD, E, EA, FI, G, K, KEP, L, LAE, LD, Manokwari, MAU, MEL, NSW, NY, P, PNH, SAR, SING, U, US, W, Z.

Under these circumstances it was also considered unnecessary to give a complete list of collectors' numbers at the end of this paper.

e. Vernacular names. These have been omitted as I am convinced that the greater part of the names mentioned in literature and on field-labels are either quite untrustworthy or of a very local use only and as I feel myself incapable of making a selection out of the abundance of vernaculars. Local botanists are in a much better position to find out which names are reliable and of more common use and therefore of some value.

4. Acknowledgements

Finally I wish to thank all those who have helped me in so many ways. Apart from the directors of the herbaria mentioned above, who kindly put their valuable material at my disposal, often for a rather long time, and from the staffs of the herbaria at Kew, London, and Paris, who offered me hospitality, my thanks are particularly due to the members of the staffs of the Rijksherbarium and the Flora Malesiana Foundation, both at Leyden, who by their scientific as well as their technical and administrative assistance greatly facilitated my work.

GENERAL PART

I. MORPHOLOGY

Since Lam (Ann. J. Bot. Btzg 42, 1931/'32, p. 23—56 and 97—226, t. 5—7 and 11—16) already gave a broad survey of the morphology of the Malaysian *Burseraceae* in general, and of the *Canarieae* in particular, I shall mainly restrict myself to some amplifications and corrections.

1. Medullary vascular strands in the twigs.

The following types are clearly distinguishable:

Type 1. No vascular strands: 25, 26, 70, 72, 73. [1])

Type 2. All vascular strands scattered irregularly: 8, 9, 35, 50, 54, 56, 59, 61, 71, 75.

Type 3. Part of the vascular strands arranged peripherally:

a. Central ones scattered: 1, 4, 6, 8, 11, 12, 13, 14, 15, 16, 27, 37, 38, 40, 42, 43, 47, 49, 50, 51, 54, 61, 63, 65, 67, 68, 69.

b. Central ones also cylindrically arranged: 16, 17, 21, 27, 28, 35, 37, 39, 50, 61, 62, 64, 67.

Type 4. All vascular strands arranged peripherally: 1, 2, 3, 4, 5, 7, 8, 10, 11, 14, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 29, 30, 31, 32, 33, 34, 36, 40, 41, 42, 43, 44, 45, 46, 48, 50, 51, 52, 53, 54, 55, 57, 58, 60, 61, 63, 65, 66, 67, 74.

a. *Type 1.* As medullary vascular strands are absent in the *Burseraceae* with the exception only of a few apparently highly specialized genera, their absence in some species of *Canarium* might seem a primitive character. However, among the five species in which these vascular strands are absent, two, *C. zeylanicum* and *C. paniculatum,* appear to be more or less derived species in a group in which medullary vascular strands are generally present. As moreover in both these species medullary vascular strands are found occasionally, it seems likely that their absence is not a primitive character at all.

The other three species mentioned, *viz. C. baileyanum, oleiferum,* and *trifoliolatum,* are representatives of *sect. Canariellum.* This case deserves some more attention, since the section just mentioned, on account of some apparently primitive characters, might be regarded as a relic-group, which implies that here the absence of medullary vascular strands might be primary. However, let us first have a look at the other three species of section *Canariellum.*

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[1]) The figures refer to the number of the species in this monograph.

C. muelleri: type 2, vascular strands represented only by resiniferous ducts, which seems to be a specialization in the phloem of normal vascular strands. This species is closely allied to *C. baileyanum* and *C. oleiferum,* the latter being generally somewhat more specialized.

C. balansae: type 4; see, however, sub d.

C. whitei: type 2, vascular strands only consisting of sclerenchyma, which normally seems to represent a specialization of the xylem in these medullary vascular strands.

From this it might be inferred that in the three species under discussion the medullary vascular strands are in a highly specialized state and, in all probability, even more or less reduced. It seems therefore quite improbable indeed that the absence of vascular strands in three species of *sect. Canariellum* would represent a primitive character.

Concluding, it seems that the absence of medullary vascular strands in the twigs of *Canarium* should be considered as a derived feature.

b. Apart from some representatives of *sect. Canariellum, type 2* is specially characteristic of the *hirsutum*-group; in part of its species at least the peripheral strands may be cylindrically arranged.

c. *Type 3.* If a peripheral cylinder of medullary vascular strands is present, it is taxonomically speaking of little importance whether or not central strands are present. In many species more than one possibility is represented, and none of these types is restricted to one group only. Even the apparently highly advanced character of a second, central cylinder is scattered throughout the genus, with only a slight concentration in some related species of the *asperum*-group.

d. *Type 4.* The absence of central strands is the usual state, which is found in all groups of the genus. The only abnormality is shown by *C. balansae* of *sect. Canariellum*: apart from the peripheral strands, which are amphivasal, and in which the phloem mainly consists of one big resiniferous duct, the xylem consists for the greater part of sclerenchyma, whereas in the central pith a number of scattered big parenchymatic cells are present (the last remnants of reduced strands?).

e. The sequence of the types as given above is the same as that of the 'Phasen', introduced by Lam (1932a, 170—178), which sequence he supposed to be of phylogenetical value. Though at first sight this seems to be quite plausible, it is clear from the above considerations that this assumption is not supported by the taxonomic relationships, though it should be admitted that in the *Burseraceae* as a whole the absence of medullary vascular strands is more primitive than their presence. In *Canarium* it is therefore of no importance for the evaluation of the relative primitiveness of a given species.

The medullary vascular strands in a few species of *Santiria,* in one species of *Haplolobus,* and in most of the species of *Dacryodes* are mostly arranged according to type 2; in *Dacryodes* the types 3a and 4 are represented in a few species.

2. The spines of C. sumatranum.

The occurrence of spines on the twigs of young specimens of *C. sumatranum* seems to be a unique feature in the genus; they are conical, scaly, up to 7 by 4 by 3 mm, and rather hard. Possibly they are not normal emergences but represent adventitious buds. This may be cleared up by anatomical and ontogenetical examination of fresh material.

3. Leaf.

As to the leaf I may refer to the extensive treatment by Lam (1932a, 147—159) in which he concluded that the pinnate leaf of the *Burseraceae* very well may be homologous with a branch. This theory is criticized on anatomical grounds by Sinia (1938, 69—105), and is in my opinion also in contradiction with the ontogenetical facts.

4. Stipules.

The following types are distinguishable:

Type 1. Stipules absent: 29—32, 34—38, 40, 43, 44, 47—50, 54—58, 70—75.

Type 2. Stipules represented by a basal pair of small, though otherwise normal leaflets, which are inserted at the very base of the petiole: 33.

Type 3. Stipules subulate: 39—42, 45—47, 50—54, 56, 59—69.

Type 4. Stipules flat or auricle-shaped: 1—28.

Except in *Canarium*, stipules are generally absent in *Burseraceae*. The only other exceptions are *Garuga* (stipules type 2) and *Dacryodes;* in the last named genus *D. edule* shows stipules of type 2, in *D. laxa* the basal pair of leaflets is sometimes smaller, inserted slightly above the base of the petiole, and in that case they are often very caducous except for (part of) the petiolule.

a. Among the species of *type 1*, there are some in which the absence of stipules may be very well considered primitive, *viz.:*

1. the isolated *sect. Canariellum*, which seems to have retained some more relic-characters.
2. the *oleosum*-group, which shows some relationship to *sect. Canariellum,* and which is considered here as the basic group of *sect. Pimela.*
3. *C. pseudodecumanum* and possibly also the *apertum*-group, which may be related with that species.

The other species without stipules, forming part of the *pilosum* and the *hirsutum*-group, are all related to species with stipules and sometimes even only occasionally lack stipules; moreover these are all more derived species. Only in the *hirsutum*-group may the absence of stipules in some species be primitive as well (see chapter III j).

b. The only type of stipules, which is known to occur in *Burseraceae* outside *Canarium* — and which may very well be primitive — is *type 2.* In *Canarium* this type occurs only in *C. decumanum,* a species of a rather obscure relationship; it is closely allied only to *C. pseudodecumanum*, which has no stipules. This type we may call *foliolar pseudo-stipules.*

c. Among the two types of stipules which are the most common in *Canarium,* and which are not known from any other *Burseraceous* genus, *type 3*, the subulate ones, may also in our opinion be termed *pseudo-stipules,* and I agree with Lam (1932a, 159—170) that they represent the next stage in the 'regressive series', which started with the foliolar pseudo-stipules. The following two points seem in favour of this opinion:

1. Besides the situation of the stipules in *Dacryodes laxa,* especially some abnormalities in *C. hirsutum*, comparable with that case, seem to point to this derivation: *fig. 1.* Case *1a* shows that the lowest pair of leaflets is smaller and inserted more towards the base of the leaf than in normal leaves (in this case normal subulate stipules were present). The case depicted in *fig. 1b* is still more interesting: the basal pair of leaflets is inserted here still closer to the base of the petiole, the leaflets are smaller —about as small as the pseudostipules of *C. decumanum* — and their petiolules are flattened (this is in accordance with the normal subulate pseudo-stipules of this species, but stands in contrast to the petiolules of the foliolar pseudo-stipules of *C. decumanum*). Furthermore it is striking in this latter case that one of the leaflet-*blades* was detached in the herbarium-specimen, whereas normally the leaflets break off at the base of the petiolule and not at its apex; the remaining petiolule looked quite like a normal subulate pseudostipule. In the specimen I could not trace any stipule, but I am not quite certain about this point.

2. From an abnormal specimen of *C. subulatum* (*Kerr 5405*) it became evident that the bracts in *sect. Pimela* — in contradistinction to *sect. Canarium* — are homologous with the base of the petioles, the stipules taking no part in it, even being shifted rather high up on the leaf stalk. This means that in this case the stipules are no formations of the base of the petiole.

d. *Type 4.* The other kind of stipules which is within the *Burseraceae* only found in *Canarium* and here restricted to *sect. Canarium,* may be called true or secondary stipules (Lam's *meta-stipules*). In my opinion these are fundamentally different from the foregoing ones. This may be sustained by the following points:

1. As appears from a specimen of *C. kaniense* (*Clemens 1288*) the bracts are homologous with the base of the petiole and the stipules. This implies that, in contradistinction to *sect. Pimela,* in this case the stipules are formations of the base of the petiole.

2. I have tried to gain some insight into the taxonomic relationships of section *Canarium* (see chapter III). The picture I arrived at, mainly based on flower-characters, proved to be in accordance with geographical facts, and may therefore generally be regarded as trustworthy. Those species which, according to this scheme, would be most primitive, all possess very small, caducous stipules inserted at the conjunction of petiole and branchlet. In the species which seem to be more derived, the stipules are larger and more persistent and they are often inserted on the petiole. Moreover, in the last-named case the stipules function both as bud scales and as bracts. The auricle-shaped stipules seem to represent a reduced and function-less state. Though I agree with Lam that these stipules are regressive, I do not include them in his 'regressive Reihe' (pseudostipules) but rather in his 'progressive Reihe' (metastipules), in accordance with the taxonomical position of the species concerned. This opinion is supported by the variability of *C. maluense* (including forms with basal and with auricle-shaped stipules) and by that of *C. caudatum* (partly included by

Lam in his *Regressivae* under this name, partly — specimens with basal stipules — in his *Progressivae* under the name *C. pauciflorum*).

It is certainly striking that the comparative morphology of the stipules

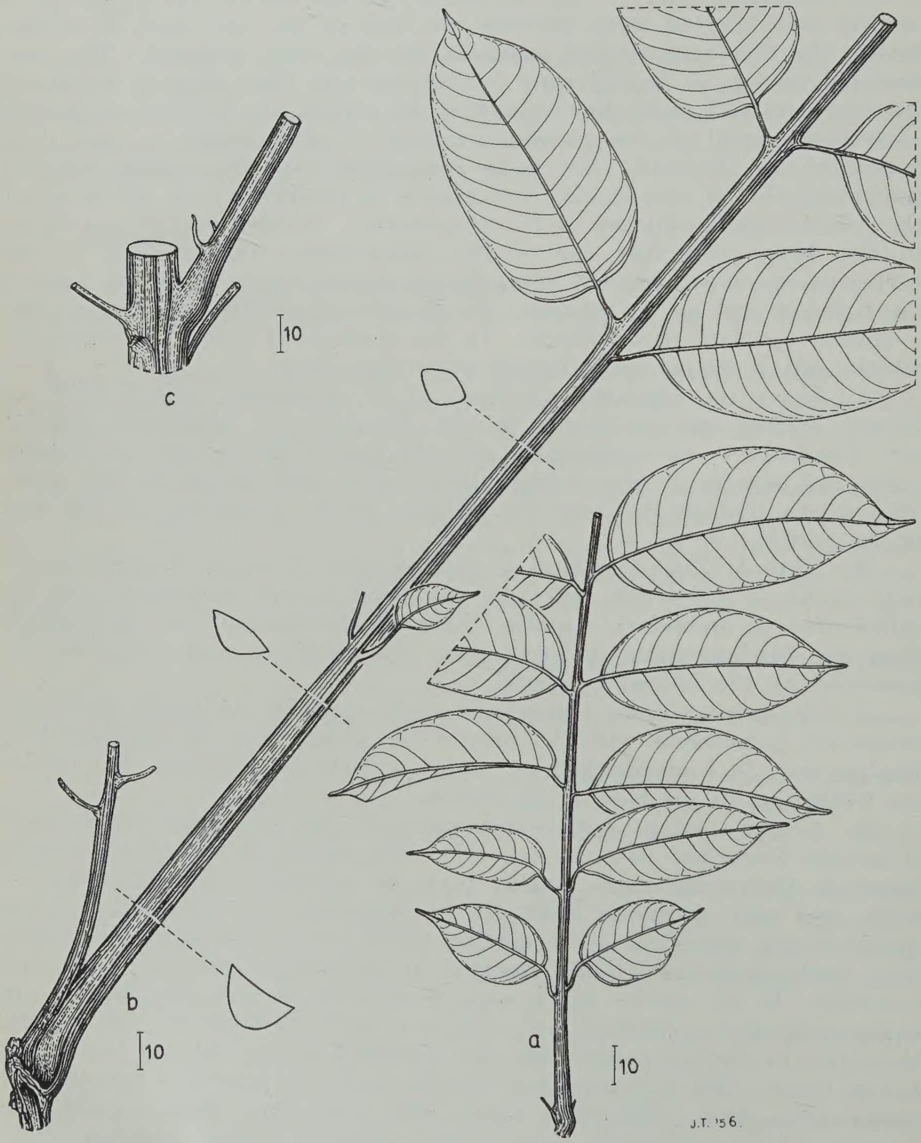

Fig. 1. Different phases in the development of subulate stipules in *C. hirsutum*. a. lowest pair of leaflets unusually small, b. lowest pair of leaflets still smaller and rather distant from the next pair, blades of the lowest pair caducous, c. normal subulate stipules. (a. from *Ahern 789*, b. from *BS. 77723*, c. from *Merrill Sp. Blanc. 909*) (dimensions in mm).

turned out to be the best basis for the taxonomy of the genus. It is Lam's merit to have discovered the importance of this character and to have used it for the first time for subdividing the genus. It is distinctly satisfactory that, whereas I based myself in my taxonomic study of the genus primarily on reproductive characters, I arrived at almost the same classification as Lam. I have only a slightly different opinion on the phylogeny of the stipular types, and hence on the position of his *Auriculatae*, as discussed above.

5. Nervation.

The nervation is often very characteristic for the species though difficult to describe precisely. In the description of the nervation I have often made use of the term *intermediate veins*. With this term I mean to distinguish veins which originate from the midrib and run more or less parallel to the nerves. Usually they are easily distinguishable from the latter as they arise much closer to the next upper than to the next lower nerve, running nearly transverse to the midrib and usually zigzagging towards the margin, forming no part of the marginal archings. Even the less well developed nerves, which are present in some species, are well distinct from the intermediate veins by the above-mentioned characters.

6. Inflorescences.

The inflorescences may be either axillary or terminal, and either thyrsoid, racemose, or spicate. Especially the first-named distinction deserves a closer consideration, as it seems to be of taxonomical value.

Type 1. Inflorescences axillary: 3, 14, 18—23, 28, 32—51, 54—71, 73—75.

Type 2. Inflorescences terminal: 1, 2, 4—8, 10—13, 15—17, 21, 23—27, 29—31, 40, 41, 52, 53, 70, 72.

a. *Axillary inflorescences* — occasionally together pseudo-terminal — are distinctly predominant in *sect. Pimela,* with only two constant (the mutually closely allied *C. dichotomum* and *fusco-calycinum*) and two occasional exceptions (the closely allied species *C. pilosum* and *merrillii,* which are possibly also related to the foregoing two species). In the two latter species truly terminal inflorescences are rare; even the usually apparently terminal inflorescences of *C. merrillii* are mostly pseudo-terminal, the vegetative terminal bud being very minute and dormant during the flowering period but developing afterwards, thus dividing the large 'terminal' inflorescence into a number of smaller axillary infructescences.

Axillary inflorescences are further known from the *decumanum*-group (the possibly related *apertum*-group possesses terminal inflorescences, however), from most species of *sect. Canariellum,* which is supposed to be rather primitive (sometimes terminal, however, in the apparently most primitive species, *C. baileyanum,* and terminal in *C. oleiferum*), and finally from nine species of *sect. Canarium.* The latter case deserves some more attention, since these 9 species fall apart into two groups, as follows:

1. *C. perlisanum, harveyi, luzonicum,* and *ovatum* are all of them

species, which are also in some other characters rather deviating and are somewhat isolated within their respective groups.

2. The same may be true for *C. schweinfurthii*, which is apparently the ultimate species in the *denticulatum-series.* This is the more interesting, at the most primitive members of this group also show axillary inflorescences: *C. odontophyllum* always (in contradistinction to the closely allied *C. littorale*), as well as *C. karoense,* usually also *C. denticulatum* and *megalanthum.* In the development towards the west this character changes abruptly, however: *C. manii, zeylanicum, paniculatum,* and *madagascariense* all possess terminal inflorescences, and only the rather isolated *C. schweinfurthii,* which is aberrant in much more characters, shows again axillary inflorescences.

b. *Terminal inflorescences* appear to be the rule in *sect. Canarium;* in this section as well as in *sect Pimela* there is some evidence that they are derived from axillary ones (see a). This opinion is in accordance with the one expressed by Lam (1932a, 144—147).

c. The shape of the inflorescences is of no great importance; usually they are thyrsoid, only in the *hirsutum* and the *asperum*-groups there is a distinct tendency towards racemose or even — in the last-named group — spicate inflorescences. Further the case of the ♂ inflorescences of *C. album* is interesting: in the Chinese specimens the lateral cymes are long and stalked, in the Indo-Chinese ones they are shorter and sessile, and, moreover, this tendency towards condensation correlates with an increasing reduction in the flowers.

7. **Bracts.**

Some abnormalities illustrate in a very clear way the origin of the bracts. As these facts have been published before (Leenhouts, 1956, 211, f. 1), and are already mentioned above (the present chapter, 4 c & d), I shall confine myself here to a short summary:

a. The narrow-triangular bracts in *sect. Pimela,* and in all probability also those in *sect Canariellum,* are homologous with the basal part of the petiole.

b. The usually much broader, more or less leafy bracts of *sect. Canarium,* which usually enclose the flower buds, and which often show some resemblance to the stipules, are homologous with a pair of stipules and a minute basal part of the petiole.

8. **Flowers.**

Since Lam (1931—32a, 23—56 & 97—137) has given an extensive survey of the flower-morphology of the family, and in particular of the present genus, I did not pay special attention to this subject. Therefore I shall restrict myself to some cases of special interest.

a. *Petals.* There are only two exceptions to the normal shape of petals; as these are both of taxonomical importance, they deserve special attention:

1. The petals in the *apertum*-group are distinctly unguiculate.

2. Some species of the *hirsutum*-group are characterized by petals, which are strongly thickened in the upper half, with much broadened and rugose valvate margins, *viz C. rigidum, polyphyllum,* and *sumatranum.*

b. *Stamens.* Coalescence of the filaments, if more than at the very base only, is nearly exclusively restricted to *sect. Pimela. C. perlisanum* (aberrant in some more characters and of unclear affinity) is the only example in *sect. Canarium.*

The reduction of the stamens in the ♀ flowers is usually very slight only.

Lam (*l. c.* 116) used the term *didynamic* in a wrong sense; as appears from his description, he meant tridynamous, as the three episepalous stamens are often slightly larger than the epipetalous ones.

c. The *androphore* of *C. schweinfurthii,* which is unique in the genus, deserves special attention. In ♂ flowers of this species the tubular disk is strongly developed, and as the stamens are adnate to the whole length of the disk and exsert beyond its rim, they seem to be inserted on its margin, and together form a cylindrical extension of the receptacle.

9. Fruiting calyx.

In fruiting specimens of *sect. Pimela* and *sect. Canariellum* the calyx is only slightly enlarged as is usual in the family; in *sect. Canarium,* however, the calyx is nearly always distinctly accrescent in fruit.

10. Fruits.

Here again I shall restrict myself to a single correction of the extensive review, given by Lam for the whole family (*l. c.* 137—144).

The structure of some sterile, though nearly fully developed fruits of the Papuan *C. megacarpum,* in which the axial part was not developed

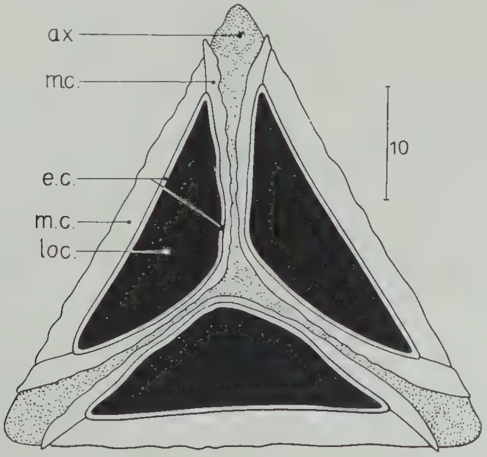

Fig. 2. *C. megacarpum,* cross-section of a sterile fruit. ax. axial part, mc. mesocarp, ec. endocarp, loc. locule (pericarp removed) (from an unnumbered specimen in *herb. L.*) (dimensions in mm).

WOOD ANATOMY IN THE GENUS CANARIUM

by Mr H. D. Ingle and Dr H. E. Dadswell

		RAYS					PARENCHYMA				FIBRES
CANARIUM SPECIES	No of samples	Horizontal gum canals	m — marginal Oxalate crystals c — central	m — marginal Silica deposits c — central	m — marginal Vesselray-pitting	c — central	Vasicentric	Sparse paratrach	Silica deposits	Oxalate crystals	Silica deposits
Section Canarium											
1. littorale	12	+	+ m	— —	+	+	+ —	+	—	—	—
4. patentinervium	1	+	+ m	— —	+	+	+ —	+	—	—	—
8. maluense	3	+	+ m	— —	+	+	—	+	—	—	—
11. sylvestre	1	+	+ m	— —	+	—	—	+	—	—	—
13. salomonense											
ssp. papuanum	5	+	+ m	— —	+	+	+	+	—	—	—
16. indicum											
var. indicum	14	+	+ m	— —	+		+	+	—	+	—
17. kaniense											
var. kaniense	1	+	+ m	— —	+	—	+	+	—	+	—
var. globigerum	1	+	+ m	— —	+	—	+	+	—	+	—
18. luzonicum	1	+	+ m	— —	+	—	+	+	—	—	—
19. ovatum	2	+	+ m	— —	+	—	+	+	—	—	—
20. odontophyllum	1	—	+ m	— —	+	—	+	+	—	—	—
21. denticulatum	3	—	+ m	— —	+	—	— +	+	—	—	—
31. apertum	2	—	—	— —	+	+	+	+	+	—	—
Incertae sedis											
32. pseudodecumanum	3	—	+ m	— —	+	+	+ —	+	—	—	—
33. decumanum	1	—	+ m	— —	+	—	—	+	—	—	—
Section Pimela											
35. balsamiferum	1	—	—	— —	+	+	—	+	—	—	—
36. trigonum	1	—	—	— —	+	+	—	+	—	—	—
37. euryphyllum	2	—	—	+ m —	+	+	—	+	—	—	+
38. gracile	1	—	+ m	+ m —	+	+		+	—	—	+
51. australianum	10	—	+ m	+ m c	+	+	—	+	—	—	+
52. dichotomum	1	—	—	— —	+	—	—	+	—	—	—
54. hirsutum	2	—	—	+ m —	+	+	— +	+	—	—	+
58. polyphyllum	1	—	+ m	— —	+			+	—	—	—
60. vrieseanum	2	—	+ m	+ m + c	+	+	—	+	—	—	+
61. asperum											
var. asperum	8	—	+ m	+ m — + c	+	+	—	+	—	—	+
var. clementis	1	—	—	+ m + c	+	+	—	+	—	—	+
ssp. papuanum	1	—	+ m	— —	+	+	—	+	—	—	—
62. schlechteri	10	—	+ m	— —	+	+	—	+	—	—	—
63. acutifolium											
var. acutifolium	12	—	(+ c 1) + m)	+ m —	+ 1)	+	— +	+	—	—	—
var. aemulans	2	—	+ m 1)	— —	+	+	— +	+	—	—	+
65. chinare	1	—	+ m	— —	+	+	—	+	—	—	—
Section Canariellum											
70. baileyanum	6	+	—	— —	+	—	—	+	—	—	—
71. muelleri	3	+	+ m	— —	+	—	—	+	—	—	—
72. oleiferum	2	+ 2)	+ m	— —	+	—	—	+	—	—	— + 3)

as well as usual, makes it seem probable that the mesocarp, together with part of the endocarp, does not only form the lids, but fully surrounds the cells (outside of the endocarp of course). See *fig. 2.* From this follows that in normal fruits the dissepiments, though appearing as a seamless whole, are really composed of both mesocarp and axial tissue. This point deserves further ontogenetical study with fresh material!

Normal fruits of the same species support Lam's opinion that the lids and the 3-winged central part are of a different origin. The pericarp of the species just mentioned is fibrous, but fibres are only inserted on the lids, not on the ribs, which are the margins of the axial intrusion.

11. Wood anatomy.

Personally, I have given no attention to this point, but Mr H. D. Ingle, of the C. S. I. R. O., Melbourne, who, together with Dr H. E. Dadswell, made an anatomical study of wood samples of many species of *Canarium,* kindly put the tabulated results of their joint study at my disposal (see p. 286). It is interesting that in many cases species, or groups of species, which are thought to be related on grounds of outer morphology also show a closer affinity anatomically. On the other hand there are some surprising exceptions, for instance the differences between the varieties of *C. acutifolium* and between the subspecies of *C. asperum.* As a whole, however, the uniformity in the sections, especially in *sect. Canarium,* is striking, and the anatomically aberrant species are generally also those which are of uncertain taxonomical affinity.

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¹) Crystals distinctive — numerous per cell.

²) Often very small and of different appearance to those in rest of family.

³) Sparse in one sample.

II. GEOGRAPHY

> "I think that a small number of well-checked and well-interpreted data from a thoroughly known group are at least as valuable towards historical biogeography as a great number of facts on a less trustworthy basis."
>
> H. J. Lam, Blumea 3, 1938, 127.

With the words quoted above in mind, I have tried in this chapter to come to a geographical analysis of the genus *Canarium*. For that purpose I have subdivided the area of the genus into 11 regions, and some of these regions into a number of subregions, all as naturally delimited geographically as possible. For the sake of convenience these regions will be dealt with from West to East.

Species which are endemic in any of the accepted regions or subregions are denoted by an asterisk.

1. Africa.

27. *C. madagascariense* *28. *C. schweinfurthii*

Of these two *C. schweinfurthii,* restricted to the Central and West African rain-forest belt, is a very remarkable species, probably derived from the same stock as *C. madagascariense*, though probably isolated for a much longer time. *C. madagascariense* ssp. *madagascariense*, in East Africa confined to the coastal region, is furthermore abundant in the drier western and central parts of Madagascar.

2. Madagascar.

27. *C. madagascariense*

Subendemic, the western subsp. *madagascariense* occurs also in East Africa. Distinctly allied to *C. paniculatum* (Mauritius) and to *C. zeylanicum* (Ceylon).

3. Mauritius.

*26. *C. paniculatum*

Endemic. Allied to *C. madagascariense* (Madagascar, E. Africa) and to *C. zeylanicum* (Ceylon).

4. Ceylon.

*25. *C. zeylanicum*

Endemic. Interrelated between *C. manii* (Andaman Isl.) on the one side, and *C. paniculatum* (Mauritius) and *C. madagascariense* (Madagascar, E. Africa) on the other.

5. **Continental S. and S.E. Asia** (including the Andaman and Nicobar Isl., but excluding the Malay Peninsula).

1. *C. littorale*
21. *C. denticulatum*
*24. *C. manii*
*42. *C. album*
*43. *C. pimela*
*44. *C. parvum*
*45. *C. subulatum*
*46. *C. bengalense*
*47. *C. strictum*
*48. *C. euphyllum*

The most surprising fact is that to sect. *Canarium* belong only three out of the above ten continental Asiatic species. This is the more remarkable as the centre of distribution of this section apparently was West Malaysia — in contradistinction to the East Malaysian sect. *Pimela,* to which the other seven species belong — and since it apparently developed early enough for reaching both Africa and Samoa. Another interesting fact is that two out of these three species of sect. *Canarium* are the only *Canarium* species which are also — and even mainly — distributed outside the present region; both make the impression to be rather recent invaders.

The seven species of sect. *Pimela* are all rather closely related; they belong to the *pilosum*-group, which is the only typically western group in this mainly E. Malaysian section.

As *Canarium* is largely a representative of the lowland rain-forest, the most appropriate geographical subdivision of the continental Asian area appeared to be the one which mainly coincides with the large plains and river-basins, which are often separated by high ranges, as follows:

a. Deccan Peninsula.

47. *C. strictum*

This species is here restricted to the moist strip of lowland in the southern and south-western part; it is further known from Sikkim, Assam, and Upper Burma, without showing distinct morphological differences. It is remarkable that it is absent from Ceylon.

b. Bengal & Assam (Lower Ganges and Brahmaputra Basins).

46. *C. bengalense*
47. *C. strictum*

Both species also in Burma, *C. bengalense* moreover known from Thailand and S. Indo-China (Laos), *C. strictum* furthermore abundant in the S.W. Deccan.

c. Burma (Irrawaddy Basin).

21. *C. denticulatum*
46. *C. bengalense*
47. *C. strictum*
48. *C. euphyllum*

Of these 4 species, two (*C. denticulatum* and *euphyllum*) point to a relationship with the Andaman and Nicobar Isl., the two others (*C. bengalense* and *strictum*) form part of a series of species which are distributed from S. Indo-China to Bengal (*C. strictum* to the S.W. Deccan).

The distribution of *C. denticulatum* offers interesting details: the Burmese specimens belong to the West Malaysian ssp. *denticulatum,* which is also distributed in the Andaman Isl. I am inclined to assume that ssp.

denticulatum is a relatively recent invader into the Andamans, and through these islands, S. Burma .

d. Andaman & Nicobar Islands.

21. *C. denticulatum*	48. *C. euphyllum*
*24. *C. manii*	

Phytogeographically these three species represent obviously more or less heterogeneous elements in the flora of this region.

C. euphyllum is distinctly related to the continental Asiatic species of the *pilosum*-group, notably to *C. strictum* and *bengalense;* moreover, the fact that *C. euphyllum* itself also occurs in S. Burma, points to a relationship between the present region and Burma.

C. denticulatum represents another element in the flora of this region. It is mainly restricted to W. Malaysia, though, besides the Andamans, it is known also from S. Burma. I am inclined to assume that it originated in West Malaysia and reached S. Burma via the Andamans.

C. manii, the only endemic species, is particularly related to *C. zeylanicum*; towards the east its relationship is undoubtedly with the *denticulatum*-group. The stock of this group must have originated rather early, however, as these species seem to be distinctly more primitive in some characters than the Malaysian representatives of the group, and are possibly closer to the *littorale*-group. *C. manii* represents the first link in a well-known biogeographical chain of affinity, which connects W. Malaysia via the Andamans, Ceylon, the Seychelles, and Madagascar (avoiding the Asiatic continent) with Africa.

It is, of course, quite risky to say anything about the time in which these species or their ancestors reached this area. *C. manii* must represent a very old element, being the first step in a series of species which even succeeded in reaching W. Africa and developed in that part of the world such an aberrant species as *C. schweinfurthii. C. euphyllum* is the only species which covers the whole subregion of the Andamans and the Nicobars, and may therefore have been a rather early invader from Burma. *C. denticulatum* seems to be a rather recent invader, though it succeeded in reaching S. Burma as well.

The geological data at hand seem to be insufficient for solving the problem of dating these migrations. The Andamans and Nicobars are part of an outer, non-volcanic arc, remainders of which are the Arakan Yoma in Upper Burma, and the islands W. of Sumatra. This arc consists of heavily folded Eocene deposits, which are discordantly covered by Miocene layers; consequently the upthrust of this region must have taken place in the Oligocene. Raised terraces and coral-reefs furthermore point to important vertical movements in the young Quarternary.

e. Thailand, Laos, Cambodia, Cochin China (Me-Kong & Me-Nam Basins).

43. *C. pimela*	46. *C. bengalense*
*45. *C. subulatum*	

Out of these three species, *C. bengalense* is a western element, reaching Bengal, and more closely allied to *C. strictum* and *C. euphyllum. C. pimela* represents the eastern species of the continental part of the *pilosum*-group. *C. subulatum* is endemic in this subregion, and is interrelated between the two other species. Therefore this subregion apparently forms the link between the *Canariums* of S. Asia and those of S.E. Asia.

f. Annam, Tonkin, & S. China (Song-koi and Song-bo Basins and coastal plains of Tonkin Bay).

1. *C. littorale*
42. *C. album*
43. *C. pimela*
*44. *C. parvum*

Three out of these 4 species (*C. album, pimela,* and *parvum*) are mutually closely allied and have the main part of their area in this region. *C. parvum* is endemic, both others occur also in Hainan, *C. pimela* is moreover known from Laos and Cambodia. These three species show doubtless close affinity to the W. Malaysian *C. pilosum,* possibly especially to its Bornean subsp. *borneense,* and to *C. merrillii,* also from Borneo.

In a way the occurrence of *C. littorale,* representing sect. *Canarium,* is exceptional. The few specimens, known from central Annam and belonging to f. *purpurascens,* are still more advanced than the typical specimens from the Malay Peninsula.

g. Hainan.

42. *C. album*
43. *C. pimela*

Both species occur also in S. China, which is not surprising. They are commonly cultivated, and their present distribution may therefore be only partly natural.

6. **West Malaysia** (Sunda-land).

1. *C. littorale*
*2. *C. latistipulatum*
*3. *C. perlisanum*
*4. *C. patentinervium*
*5. *C. caudatum*
*6. *C. divergens*
*7. *C. kinabaluense*
8. *C. maluense*
15. *C. vulgare*
20. *C. odontophyllum*
21. *C. denticulatum*
*22. *C. karoense*
*23. *C. megalanthum*
*29. *C. pseudopatentinervium*
*30. *C. grandifolium*
*31. *C. apertum*
*32. *C. pseudodecumanum*
33. *C. decumanum*
*39. *C. kostermansii*
*40. *C. pilosum*
*41. *C. merrillii*
*49. *C. intermedium*
*50. *C. kipella*
*52. *C. dichotomum*
*53. *C. fusco-calycinum*
54. *C. hirsutum*
?*55. *C. pseudosumatranum*
*56. *C. sumatranum*
61. *C. asperum*

Out of these 29 species (18 of which belong to sect. *Canarium,* 11 to sect. *Pimela*) 21 (or 20?) are endemics — 12 of these apparently very local —, 1 (*C. littorale*) is subendemic, and 7 species have a wider distribution (*C. maluense* is represented, however, by an endemic subspecies). These conditions point to a high degree of isolation in this part of the area.

Let us first of all have a closer look at these groups in general.

Among the endemics, 12 (among which 6 local endemics) belong to sect. *Canarium* and 9 (or 8?) to sect. *Pimela* (among which are 6 local endemics). The endemic species of sect. *Canarium* all belong to those which I regard as being relatively primitive; moreover, *C. littorale,* the species assumed to be the most primitive one in many respects, is subendemic (furthermore known only from central Annam in a few morphologically extreme specimens). The only representative of the more advanced *maluense*-group, *C. maluense* ssp. *borneense,* endemic in E. Borneo, is regarded as being the typological base of that group. All this strengthens the supposition that this part of the Malay Archipelago should be considered to represent the centre of origin, or at least the main centre of distribution, of this section. The endemic species of sect. *Pimela,* on the contrary, mainly belong to the more advanced *pilosum* and *dichotomum*-groups; two species (*C. pseudosumatranum,* possibly occurring also in Burma, and *C. sumatranum*) are rather restricted in distribution, and are related to the widely distributed *C. hirsutum,* a species that has developed several local endemics along the margin of its area.

Among the 7 more widely distributed species, 2 are mainly western, extending their area only slightly outside the present region, the other 5 are mainly East Malaysian, extending their area more or less to West Malaysia. The two principally West Malaysian species are *C. odontophyllum* and *C. denticulatum*; they are rather close relatives, the former occurs also in Palawan, the latter extends to Mindanao to the east and to the Andamans and S. Burma on the west side. Among the 5 East Malaysian species, 3 (*C. maluense*. represented by an endemic subsp. in E. Borneo; *C. decumanum,* also in E. Borneo; *C. vulgare* in Bawean and Kangean) touch only the border areas of Sunda Land. The two remaining ones (*C. hirsutum* and *C. asperum*) are distributed throughout the greater part of the Malaysian Archipelago. These two species apparently originated in E. Malaysia; in W. Malaysia, which they probably reached via the Philippines, their variability is strongly diminished, and here *C. asperum* is even only known from Borneo, Bawean, and Kangean.

After these general considerations, we may have a closer look at the subdivisions of the region.

a. Sumatra (incl. the adjacent islands).

1. *C. littorale*
4. *C. patentinervium*
5. *C. caudatum*
20. *C. odontophyllum*
21. *C. denticulatum*
*22. *C. karoense*
23. *C. megalanthum*
29. *C. pseudopatentinervium*
31. *C. apertum*
32. *C. pseudodecumanum*
40. *C. pilosum*
*49. *C. intermedium*
52. *C. dichotomum*
54. *C. hirsutum*
56. *C. sumatranum*

Out of these 15 species, 12 are West Malaysian endemics. Only 2, however, are restricted to Sumatra (*C. karoense* and *C. intermedium*). It is not surprising that only one of the more widely distributed, originally East Malaysian species, *viz. C. hirsutum,* reaches Sumatra.

Though Sumatra is apparently the centre of origin of *C. littorale*, and therefore of the whole *littorale*-group, and possibly also of the *denticulatum*-group, it seems to have been a much less important centre of speciation than for example Borneo, or even the Malay Peninsula.

b. Malay Peninsula.

1. *C. littorale*
*3. *C. perlisanum*
4. *C. patentinervium*
5. *C. caudatum*
21. *C. denticulatum*
23. *C. megalanthum*
*30. *C. grandifolium*
31. *C. apertum*
32. *C. pseudodecumanum*
40. *C. pilosum*
54. *C. hirsutum*
*55. *C. pseudosumatranum*
56. *C. sumatranum*

There are 13 species in all, among which 10 are West Malaysian endemics. Only 3 of these (*C. perlisanum, grandifolium*, and *pseudosumatranum*, the latter possibly also in Burma) are endemic in the Malay Peninsula. Consequently the picture is not very different from that in Sumatra. Here again, *C. hirsutum* is the only species with a wide area and East Malaysian relationships. All the other species are distributed throughout W. Malaysia, with the occasional exception of Java. *C. sumatranum* is the only species which is restricted to Sumatra and the Malay Peninsula; this is to be considered one of the marginal endemics of *C. hirsutum*.

c. Java (including Madura, Bawean, and Kangean).

1. *C. littorale*
15. *C. vulgare*
21. *C. denticulatum*
*50. *C. kipella*
54. *C. hirsutum*
61. *C. asperum*

There are 6 species, of which one endemic (*C. kipella*, in W. Java, closely allied to *C. intermedium* of S. Sumatra). West Malaysian endemics are furthermore absent. The only other typically West Malaysian species present are *C. littorale* and *C. denticulatum*, which both have an area slightly extending outside of W. Malaysia. Out of the three East Malaysian species two (*C. vulgare* and *asperum*) are here restricted to Bawean and Kangean; they are the only representatives of the genus on these small islands, which in this respect are apparently more closely related to E. Malaysia than to Java. *C. hirsutum*, finally, is found in all parts of Malaysia. In conclusion, the peculiar feature of this subregion is the relative paucity of species and the remarkable situation that 2 out of the 3 eastern species occur only in small islands which are very close to the mainland of Java but obviously occupy a singular position of eastern relationships as far as *Canarium* is concerned.

d. Borneo.

1. *C. littorale*
*2. *C. latistipulatum*
4. *C. patentinervium*
5. *C.caudatum*
*6. *C. divergens*
31. *C. apertum*
32. *C. pseudodecumanum*
33. *C. decumanum*
*39. *C. kostermansii*
40. *C. pilosum*

*7. *C. kinabaluense*
8. *C. maluense*
20. *C. odontophyllum*
21. *C. denticulatum*
23. *C. megalanthum*
29. *C. pseudopatentinervium*
*41. *C. merrillii*
52. *C. dichotomum*
*53. *C. fusco-calycinum*
54. *C. hirsutum*
61. *C. asperum*

The striking points are the large number of species (21 out of the 29 West Malaysian ones) and the high degree of endemism (6 species and 3 subspecies). These endemics all form part of West Malaysian groups, with the exception only of *C. maluense* ssp. *borneense.* The latter, however, is very close to the West Malaysian *littorale*-group, and in the author's opinion represents the link between that group and the East Malaysian *maluense*-group.

It is interesting to mention two closely related West Malaysian species (*C. odontophyllum* and *denticulatum*) both of which apparently have their centre of origin in Sumatra, and have developed more advanced forms in Borneo. Moreover, of these two species one (*C. odontophyllum*) reached Palawan, the other (*C. denticulatum*) extends its area to Mindanao and Basilan; accordingly they demonstrate the two possible connections between Borneo and the Philippines.

Finally, 3 species which have apparently their centre of origin in E. Malaysia, are present in Borneo. One of these, *C. decumanum,* is not known from the Philippines, and in Borneo it occurs apparently only in the S.E. part. Taxonomically speaking, it is possibly to be considered a relic species, and, together with *C. maluense,* which also is unknown from the Philippines, it seems to be an example of the possibility for a direct crossing of Macassar Strait. *C. hirsutum* and *C. asperum* have obviously reached Borneo via the Philippine track, according to the distributional patterns of the infraspecific taxa of these species.

7.Philippines.

*18. *C. luzonicum*
*19. *C. ovatum*
20. *C. odontophyllum*
21. *C. denticulatum*
*37. *C. euryphyllum*
*38. *C. gracile*
54. *C. hirsutum*
60. *C. vrieseanum*
61. *C. asperum*

The phytogeographical position of the Philippines concerning *Canarium* is rather interesting. Out of the comparatively small number of 9 species 4 are endemics — 2 probably and 2 possibly of East Malaysian origin, but all of them obviously isolated for rather a long time —, 2 are West Malaysian species which slightly penetrate into the Philippines, and the 3 remaining ones are East Malaysian, two of which are distributed throughout the greater part of Malaysia. These latter 3 species are represented in the Philippines by endemic varieties or forms.

Among the 4 endemics, two (*C. euryphyllum* and *gracile*) belong to sect. *Pimela,* which is chiefly East Malaysian, the other two (*C. luzonicum* and *ovatum*) to sect. *Canarium,* mainly West Malaysian. It is striking that the taxonomical position of all of these 4 species is somewhat puzzling.

C. euryphyllum and *gracile* are treated in the special part as specialized members of the *oleosum*-group — which is supposed to be the basic one of sect. *Pimela* —, but there remains some doubt whether or not *C. euryphyllum* is related to *C. hirsutum,* and *C. gracile* either to *C. merrillii* (Borneo) or to *C. dichotomum* (W. Malaysia). In any case, they have apparently been isolated during a rather long time. The two other species, *C. luzonicum* and *ovatum*, form part of the East Malaysian *vulgare*-group, though in some characters especially *C. luzonicum* shows some relationship with the western *littorale*-group, from which, in my opinion, the *vulgare*-group must have developed; the unusual axillary inflorescences of both species are also possibly relic-characters. Summarizing, the endemics point both to a rather high degree of isolation and to a predominant relationship with E. Malaysia, and there is some possibility, that the two representatives of the *vulgare*-group are to be considered remnants of an old track from W. Malaysia via the Philippines to E. Malaysia.

The two West Malaysian species, *C. odontophyllum* (Palawan) and *C. denticulatum* (Basilan and Mindanao), are both common in Borneo. They may demonstrate the two possible tracks from Borneo to the Philippines, assuming, of course, that theirs are no relic areas.

Among the three East Malaysian species, *C. vrieseanum* is, outside the Philippines, restricted to Celebes (2 endemic forms in the Philippines, the third one in Celebes). *C. hirsutum* and *asperum,* both probably of East Malaysian origin, but distributed throughout the greater part of the Malay Archipelago, are striking by their great variability in the Philippines. This variability mainly concerns the vegetative parts, however, and may therefore in part be due to ecological factors. One of the less advanced forms of both of these species reached W. Malaysia.

The conclusion is that the non-endemic species stress both the mainly East Malaysian relationship of the Philippines and their position as a bridge between E. and W. Malaysia, in which in more recent times the general direction seems to be from east to west.

Finally, the exceptional position of Palawan has to be mentioned. Its only three *Canarium* species are *C. odontophyllum, C. hirsutum,* and *C. asperum*; of the two last-named species only those forms which also occur in W. Malaysia. All typically Philippine elements are therefore lacking and, as far as *Canarium* is concerned, the flora of Palawan is a very impoverished Bornean one.

8. East Malaysia (including the Lesser Sunda Islands and the Aru Islands).

8. *C. maluense*
*9. *C. megacarpum*
*10. *C. lamii*
*11. *C. sylvestre*
*12. *C. piloso-sylvestre*
13. *C. salomonense*
15. *C. vulgare*
16. *C. indicum*
*17. *C. kaniense*
*36. *C. trigonum*
51. *C. australianum*
54. *C. hirsutum*
*57. *C. rigidum*
*58. *C. polyphyllum*
*59. *C. cestracion*
60. *C. vrieseanum*
61. *C. asperum*
*62. *C. schlechteri*

33. *C. decumanum*
*34. *C. oleosum*
*35. *C. balsamiferum*
*63. *C. acutifolium*
*64. *C. macadamii*
65. *C. chinare*

There are 24 species in all, 10 of which belong to the principally western sect. *Canarium,* 14 to the typically East Malaysian sect. *Pimela.* Out of the 24 species, 14 are endemic (8 of very local occurrence), 3 subendemic (all slightly penetrating into W. Malaysia, and all belonging to sect. *Canarium*!), and 7 species are more widely spread, 4 of these in an eastern direction (Pacific, Australia), and 3 towards the Philippines (among these the two wide-spread species *C. hirsutum* and *asperum,* the latter one also on Bawean and Kangean Islands).

Before dealing with the subregions, we will again have a somewhat closer look at these phytogeographically differing groups of species.

Among the 14 endemics, 5 belong to sect. *Canarium,* 9 to sect. *Pimela.* The 5 species of sect. *Canarium,* as well as all other representatives of this section in E. Malaysia, belong to two groups, *viz.* the *maluense* and the *vulgare*-group, the only exception being *C. decumanum.* the taxonomical position of which is uncertain. In my opinion, the *maluense* as well as the *vulgare*-group are relatively advanced within sect. *Canarium*; both have their chief distribution in E. Malaysia and Melanesia. The former is moreover represented in Borneo by *C. maluense* ssp. *borneense,* which forms a link with the more primitive western *littorale*-group. The latter is represented by *C. vulgare* — its most western species — in Bawean and Kangean (islands which, phytogeographically speaking, had probably better be included in E. Malaysia) and by two rather isolated species (*C. luzonicum* and *ovatum*) in the Philippines. All these facts seem to support the author's opinion, that sect. *Canarium* has to be considered of West Malaysian origin.

Likewise, the evidence derived from the endemics of sect. *Pimela* seem to point to an East Malaysian origin of this section. Its 9 species (5 of which local endemics) belong to several groups; 3 of them are even the possibly most primitive species of the allegedly basic *oleosum*-group. Of the two western groups, which are both advanced in many characters, the *dichotomum*-group is entirely absent, the *pilosum*-group being represented only by *C. australianum.* Furthermore the relationship with W. Malaysia in this section is restricted to two wide-spread species, *C. hirsutum* and *asperum.* The relationship with the Philippines is slightly stronger, but of greater importance is the relationship with the Pacific. In these respects the representatives of both sections show the same picture.

The 7 more widely spread species, finally, more or less emphasize the picture shown by the endemics and subendemics. Two of them belong to sect. *Canarium,* both going as far as the Solomon Islands (*C. salomonense* in the present region being represented by an endemic subsp.). Out of the 5 representatives of sect. *Pimela,* 2 (already mentioned above) are more widely distributed, one (*C. vrieseanum*) is represented in the Philippines by an endemic form, one (*C. australianum*) is also known from Australia, and one (*C. chinare*) from the Solomon Islands.

We will now pay some attention to the various subregions:

a. Celebes.

8. *C. maluense*
15. *C. vulgare*
33. *C. decumanum*
34. *C. oleosum*
35. *C. balsamiferum*
*36. *C. trigonum*
54. *C. hirsutum*
60. *C. vrieseanum*
61. *C. asperum*
63. *C. acutifolium*

First of all, it is interesting to note the low degree of endemism in regard of the fact that the number of species is not particularly small. The only endemic species, *C. trigonum*, is moreover closely allied to *C. balsamiferum*; further there are only some endemic varieties and forms.

A second point worth mentioning is, that both species belonging to sect. *Canarium* (*C. maluense* and *vulgare*) are regarded as primitive in their respective groups, and accordingly stress the supposition of a western origin of this section, pointing to Celebes as the gate through which this section — either directly from Borneo or indirectly via the Philippines — reached E. Malaysia.

For the rest, the relationships are mainly to the east. Besides the two wide-spread species *C. hirsutum* and *C. asperum*, the Philippines have only *C. vrieseanum* in common with Celebes, a species, which in the Philippines is restricted to Mindanao and in Celebes to the Northern Peninsula. The occurrence of *C. vulgare* and *C. asperum* in Bawean and Kangean is possibly less interesting in this connection, since both species are also known from the Lesser Sunda Islands.

Finally, it may be of some importance that the three allegedly most primitive species of the *oleosum*-group are represented; *C. trigonum* is endemic, *C. oleosum* is also known from the Moluccas, and *C. balsamiferum* from the Moluccas and New Guinea. This may indicate that Celebes possibly one time either formed part of the centre of origin of sect. *Pimela*, or was very close to it.

b. Lesser Sunda Islands.

15. *C. vulgare*
34. *C. oleosum*
61. *C. asperum*

All three species are principally East-Malaysian and occur also at least in Celebes and the Moluccas. Though none of them occurs in Java, two (*C. vulgare* and *asperum*) are known to occur in Bawean and Kangean. In the present subregion all are restricted to the eastern part (*C. vulgare* goes as far west as Flores — specimens from more western localities are probably cultivated —, *C. oleosum* reaches Timor, *C. asperum* Sumbawa).

c. Moluccas.

8. *C. maluense*
11. *C. sylvestre*
15. *C. vulgare*
16. *C. indicum*
33. *C. decumanum*
34. *C. oleosum*
35. *C. balsamiferum*
54. *C. hirsutum*
61. *C. asperum*
63. *C. acutifolium*

Though the number of species is fairly large it is rather surprising that none of them is endemic, but there are two endemic infraspecific taxa.

The section *Canarium* is represented by 5 species: the three already known from Celebes (*C. maluense, vulgare,* and *decumanum*), and 2 species, *C. sylvestre* and *C. indicum*, which represent more advanced types in the *maluense*-group and the *vulgare*-group *resp.* The two last-named species, as well as *C. maluense* and *C. decumanum,* extend their area farther to the east. These facts fit very well in the supposed gradual alteration of these two groups from west to east.

Sect. *Pimela* is also represented by 5 species, all also known from Celebes. It is interesting, however, to note the presence of the two supposedly most primitive species of this section — *C. oleosum* and *balsamiferum* — as well as the great variability of *C. hirsutum* and *C. asperum* in this subregion, the more so, as both these latter species are, among others, represented by their least specialized forms. *C. hirsutum* is even represented by its two subspecies, one of which spreads eastward, while the other is mainly distributed towards the west. It therefore seems that the Moluccas have played an important role in the history of the section *Pimela,* either as its centre of origin, or as an early and important secondary centre.

There are apparently no distinct differences between the North and the South Moluccas; from west to east there is a slight and gradual substitution of species, however. The 3 species known from the (Eastern) Lesser Sunda Islands also occur in the Moluccas.

d. New Guinea, including the Bismarck Archipelago.

8. *C. maluense*
*9. *C. megacarpum*
*10. *C. lamii*
11. *C. sylvestre*
*12. *C. piloso-sylvestre*
13. *C. salomonense*
16. *C. indicum*
*17. *C. kaniense*
33. *C. decumanum*
34. *C. oleosum*
35. *C. balsamiferum*
51. *C. australianum*
54. *C. hirsutum*
*57. *C. rigidum*
*58. *C. polyphyllum*
*59. *C. cestracion*
61. *C. asperum*
*62. *C. schlechteri*
63. *C. acutifolium*
*64. *C. macadamii*
65. *C. chinare*

New Guinea being both the largest landmass in E. Malaysia and the link between Malaysia on one side and Australia, Melanesia, and Polynesia on the other, neither the large number of species, nor the high degree of endemism is surprising (21, *resp.* 9); both numbers are of the same order as the Bornean ones, and in both cases our knowledge is doubtless still very insufficient.

Sect. *Canarium* is again — with the exception only of *C. decumanum* which is of uncertain relationship — represented by its two eastern groups, the *maluense* and the *vulgare*-group. Especially the *maluense*-group is well developed, being represented by 6 species, 3 of which are endemics. *C. maluense* and *C. sylvestre* are furthermore distributed to the west, the latter seems also in New Guinea to be restricted to the western half. The 3 endemics are related to these two western species, and are also known only from Western New Guinea. *C. salomonense* is the only representative of the *maluense*-group which extends its area to the east; in New Guinea it is represented (only in the eastern half!) by an endemic subspecies. As to the two representatives of the *vulgare*-group, *C. indicum* extends its area farther to the west and to the east, and *C. kaniense* is distinctly related to this species, though in some characters slightly more specialized.

C. decumanum, in a western direction reaching as far as E. Borneo, is in New Guinea only known from the Vogelkop Peninsula.

Sect. *Pimela* is represented by 12 species, 5 of which are endemic. The *oleosum*-group, which I regard as the most primitive one, here reaches its eastern boundary; *C. oleosum* and *balsamiferum* are present. The more advanced *hirsutum* and *asperum*-groups are here fairly much diversified. Interesting, though puzzling, is the position of *C. australianum,* a species of E. New Guinea and N.E. Australia, which meanwhile comes closest to the West Malaysian *pilosum*-group.

The *hirsutum*-group is especially well represented. *C. hirsutum,* which itself is distributed all over the Malaysian Archipelago and the Solomon Islands, seems here, as well as in Sumatra and the Malay Peninsula, to have given rise to some marginal endemics (*C. rigidum, polyphyllum,* and *cestracion*). A striking fact is the similarity in many characters, especially in the strongly thickened petals, between *C. sumatranum* in W. Malaysia on the one side, and on the other side the Papuan species *C. polyphyllum, rigidum,* and possibly also *C. cestracion* (the flowers of which are still unknown).

The *asperum*-group is represented by 5 species, as follows: *C. asperum,* distributed throughout the greater part of the Malaysian Archipelago and Melanesia, is in New Guinea represented by both its subspecies, one of which (ssp. *papuanum*) is endemic, the other (ssp. *asperum*) being represented by some wide-spread forms. *C. schlechteri* is endemic and allied to *C. asperum* and *C. acutifolium. C. acutifolium* is furthermore known from Celebes, where it is represented by a distinctly more primitive, endemic variety. *C. macadamii* is endemic and closely allied to *C. acutifolium. C. chinare* is further known from the Solomon Islands and allied to some other Melanesian species of the *asperum*-group.

Obviously, the wealth of species, and also of endemics, is somewhat greater in the eastern half of the island as compared to the western part. This may partly be due to the larger amount of material from the eastern half, but my impression is that this is not the only cause. There are some species, *e.g. C. sylvestre,* which are apparently rather common in the western half and are unknown from the eastern part. Apparently, there is some shifting in the species-composition indeed, going from west to east; some western species reach their eastern boundaries, some eastern ones their western boundaries somewhere in New Guinea. As far as known, 5 species are here restricted to the western half (*C. megacarpum, lamii, sylvestre, piloso-sylvestre,* and *decumanum*), two of these, *C. piloso-sylvestre* (a local endemic, closely related to *C. sylvestre*) and *C. decumanum,* even to the Vogelkop Peninsula. All these are representatives of the originally West Malaysian sect. *Canarium*, 4 of them representing the *maluense*-group. The *maluense*-group is in the eastern part represented by 2 species only, *viz. C. maluense*, which is the least specialized and most widely spread species of this group, and *C. salomonense*. The last-named species possibly entered New Guinea from the Solomon Islands, as the New Guinea subsp. *papuanum*, in some characters, especially some reductions in the fruit, seems to be more specialized than the subspecies of the Solomons, and moreover, ssp. *papuanum* is known only from the Northern Div. of Papua.

There are 9 species here restricted to the eastern part (*C. salomonense, kaniense, balsamiferum, australianum, rigidum, cestracion, chinare, macadamii,* and *schlechteri*). Only two of these belong to the western sect. *Canarium*, viz. *C. salomonense*, discussed above, and *C. kaniense*, which is a more specialized local endemic, closely allied to *C. indicum*. The remaining species all belong to the eastern sect. *Pimela*. One out of these 7 species, viz. *C. balsamiferum*, presents a good example of the incompleteness of our knowledge of the Papuan flora. Up till 1953 it was known only from Celebes and the Moluccas; in that year Brass collected a specimen on the Cape Vogel Peninsula, the easternmost point of New Guinea, and reported it to be common. It seems not likely that it is introduced there. *C. australianum* shows the same variability as the Queensland specimens, and is restricted to the regions along Torres Strait. The other species are all endemics or subendemics, belonging to the *hirsutum* or *asperum*-groups.

So far as *Canarium* is concerned, the Bismarck Archipelago (with the inclusion of the Admiralty Islands) has an impoverished Papuan flora; all 6 species (*C. indicum, oleosum, hirsutum, schlechteri, acutifolium,* and *chinare*) are also known from the mainland of New Guinea.

9. Micronesia.

54. *C. hirsutum*

This widely distributed species is known from the Palau Islands; the specimens seem to be related to Philippine ones.

10. Melanesia & Western Polynesia.

13. *C. salomonense*
*14. *C. harveyi*
16. *C. indicum*
54. *C. hirsutum*
61. *C. asperum*
65. *C. chinare*
*66. *C. vanikoroense*
*67. *C. smithii*
*68. *C. vitiense*
*69. *C. samoense*
*72. *C. oleiferum*
*73. *C. trifoliolatum*
*74. *C. balansae*
*75. *C. whitei*

There are 14 species in all, 9 of which are endemics and 2 subendemics (1 represented by an endemic subsp.).

The three more widely distributed species are all East Malaysian ones, which apparently, coming from New Guinea, reached Melanesia: *C. hirsutum* and *asperum* are known from the Solomon Islands only, *C. indicum* is also known from the New Hebrides but since the last-named species is frequently cultivated by the natives of Melanesia on account of its fruits, its natural eastern boundary is somewhat uncertain.

As to the two subendemics, *C. salomonense* is furthermore represented in E. New Guinea by an endemic subspecies and *C. chinare* is also known by somewhat dubious specimens from the Admiralty Islands and New Guinea.

The 9 endemic species are distributed among the sections as follows: sect. *Canarium* 1 species (*C. harveyi*, belonging to the East Malaysian *maluense*-group); sect. *Pimela* 4 species (*C. vanikoroense, smithii, vitiense,* and *samoense*, all closely related to *C. asperum*, which itself reached the Solomon Islands); sect. *Canariellum* 4 species, restricted to New Caledonia and the Loyalty Islands.

Summarizing, there is a close relationship to New Guinea, though only very few species cross the boundary between the two regions and none of these goes farther east than the New Hebrides. The *Canarium* assemblage of the Fiji, Tonga, and Samoa Islands is exclusively composed of Melanesian endemics. New Caledonia stands quite apart, and is more related to Queensland as far as *Canarium* is concerned.

We now deal with the different subregions in somewhat more detail.

a. Solomon Islands.

13. *C. salomonense*
14. *C. harveyi*
16. *C. indicum*
54. *C. hirsutum*
61. *C. asperum*
65. *C. chinare*

Among these 6 species 3 are rather widely spread East Malaysian ones (*C. indicum, hirsutum*, represented by the Papuan var. *leeuwenii*, and *C. asperum*, the two last-named taxa reaching their eastern boundary here), 2 are subendemic, slightly extending their area to the west (*C. salomonense*, with an endemic subspecies in the extreme eastern part of New Guinea, and *C. chinare*, probably also on the Admiralty Islands and East New Guinea) and one species (*C. harveyi*) is Melanesian, found as far east as Samoa. Local endemics (except for some infraspecific taxa) are absent. So, even in its species-composition, this subregion is still predominantly Malaysian.

b. New Hebrides.

14. *C. harveyi*
16. *C. indicum*
66. *C. vanikoroense*

The first two species also occur in the Solomons; the Malaysian *C. indicum* reaches its eastern boundary here, *C. harveyi* is Melanesian (here represented by an endemic variety). *C. vanikoroense*, on the other hand, is the most western one of the small group of Melanesian endemics, belonging to the *asperum*-group. Its relationship may be as well with *C. chinare* in the west as with *C. smithii* in the east; the species itself is also known from Fiji.

c. Fiji Islands.

14. *C. harveyi*
66. *C. vanikoroense*
*67. *C. smithii*
*68. *C. vitiense*

In contradistinction to the New Hebrides the number of species is slightly larger and all are Melanesian endemics. *C. harveyi* is the only widely spread Melanesian species. The three others belong to the *asperum*-group of sect. *Pimela*. They are closely related, both mutually and to *C. samoense* of Samoa. Two are endemics, *C. vanikoroense* is also known from the New Hebrides. It may be that Fiji has acted as a secondary centre of speciation in Melanesia.

d. Samoa Islands.

14. *C. harveyi*
*69. *C. samoense*

One endemic species (*C. samoense*), closely allied to *C. smithii* and *vitiense* of Fiji. *C. harveyi* is widely spread in Melanesia and represented here by var. *harveyi*, which is also known from Fiji and Tonga.

e. Tonga Islands.

14. *C. harveyi*

A widely spread Melanesian species; the same var. *harveyi* also known from Fiji and Samoa.

f. New Caledonia & Loyalty Islands.

*72. *C. oleiferum*
*73. *C. trifoliolatum*
*74. *C. balansae*
*75. *C. whitei*

These 4 species, all endemic, belong to sect. *Canariellum*, which is furthermore only represented in Queensland. This high degree of endemism is in complete agreement with the picture as given by many other taxa, and again demonstrates the prolonged isolation of this region.

C. oleiferum is the most interesting of these species. Apparently it is the only one which is spread all over New Caledonia. Moreover, it is the only species, the affinities of which are clear: it is rather closely related to the Australian species of the same section, *C. muelleri* and *baileyanum*; in some characters it seems to be somewhat more specialized, however. Therefore, we are inclined to conclude that *C. oleiferum* reached New Caledonia from Queensland.

The affinities of the other species are much less clear. All show some peculiar characters, part of which may be primitive ones. This points obviously to a long isolation. Two of them are very rare endemics of New Caledonia, *C. balansae* is only known from the Loyalty Islands.

11. Australia.

51. *C. australianum*
*70. *C. baileyanum*
*71. *C. muelleri*

In Australia, the genus *Canarium* is restricted to Arnhem's Land and North and East Queensland. Among the 3 species, *C. australianum*, representing sect. *Pimela*, is subendemic — being also known from South New Guinea — and occupies at the same time the largest area in Australia. The two other species, both endemics, are restricted to Queensland. *C. baileyanum* and *muelleri* belong to sect. *Canariellum*; they are closely allied to *C. oleiferum* from New Caledonia but seem to be slightly more primitive in some characters. *C. baileyanum* has a rather wide distribution (Cook Peninsula to Lismore, N.S.W., about 28° 30′ S, much farther south than *C. australianum*). *C. muelleri* is apparently a very local species (Cook Peninsula, Atherton Distr., about 17—18° S and 145—146° E). In my opinion these two species have to be considered as relics.

C. australianum is an interesting species. In Australia it is more restricted to the tropical rain-forest than is *C. baileyanum*, and extends southward only to about 19 or 20° S. It certainly belongs to sect. *Pimela*, and shows a distinct relationship to the *pilosum*-group, which for the rest is West Malaysian. On the other side, *C. australianum* shows some vegetative characters, which it has in common only with the section *Canariellum*, with the *oleosum*-group, and with the *decumanum*-group, all groups, which are supposed to be relatively primitive. Finally, the species occurs also in South New Guinea, showing the same range of variability there as in Australia.

III. COMPARATIVE TAXONOMY

> "Ik weet dat het geheim mij telkens weer ontvliedt. Maar het éven gezien te hebben, iets ervan (al verbeeld ik het mij misschien maar) te hebben vastgelegd — ik vraag niet meer."
>
> P. Geyl, 1958.

1. Introduction.

The scope of this chapter is to arrive at a synthesis of the genus as a whole instead of looking at it as a group of more or less independent, equivalent species.

Not unintentionally did I choose the title 'Comparative Taxonomy' for this chapter, not 'Phylogeny'. A chapter on phylogeny would pretend to give the genesis of the taxa along the time-axis. As fossils are fully unknown, I can work only in one time level, the present one; no more can be done than arranging the facts at my disposal — primarily morphological, secondarily geographical ones — in accordance with the supposed relationships between the species, trying to define the typological centres of these groups, and finally arranging these centres, their basic types, and by the latter the groups. The best to be expected is that the scheme given may, in its main lines, more or less approach the projection of the phylogeny upon its upper time level. Accordingly, the terms 'primitive' and 'advanced', though often used and apparently suggesting some direction in the relationships and lending some dynamism to the system, have been used in a typological sense and for shortness' sake only. They never mean to point to a direct derivation of a recent species from another recent one, even though in itself such a procedure is far from impossible.

2. Discussion.

The 'Bauplan' or type ¹) of the genus *Canarium,* based upon: comparison with related, less specialized genera, and a mutual comparison of all the characters represented in the genus as to primitiveness (as far as anything can be reasonably stated), may be characterized within the genus as follows:

Pith of the branchlets probably with resiniferous vascular strands. Leaves exstipulate. Inflorescences axillary, thyrsoid; bracts narrowly deltoid, homologous with the basal part of the petiole. Flowers dioecious (or possibly still bisexual?), (4?—)3-merous. Receptacle flat. Stamens 6, biseriate,

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¹) The word *'type'* is here used in a typological, not in a nomenclatural sense; it means a hypothetical plant, showing in all its characters either the most primitive state represented in the group concerned, or such a primitive state that all structures observed can be derived from it.

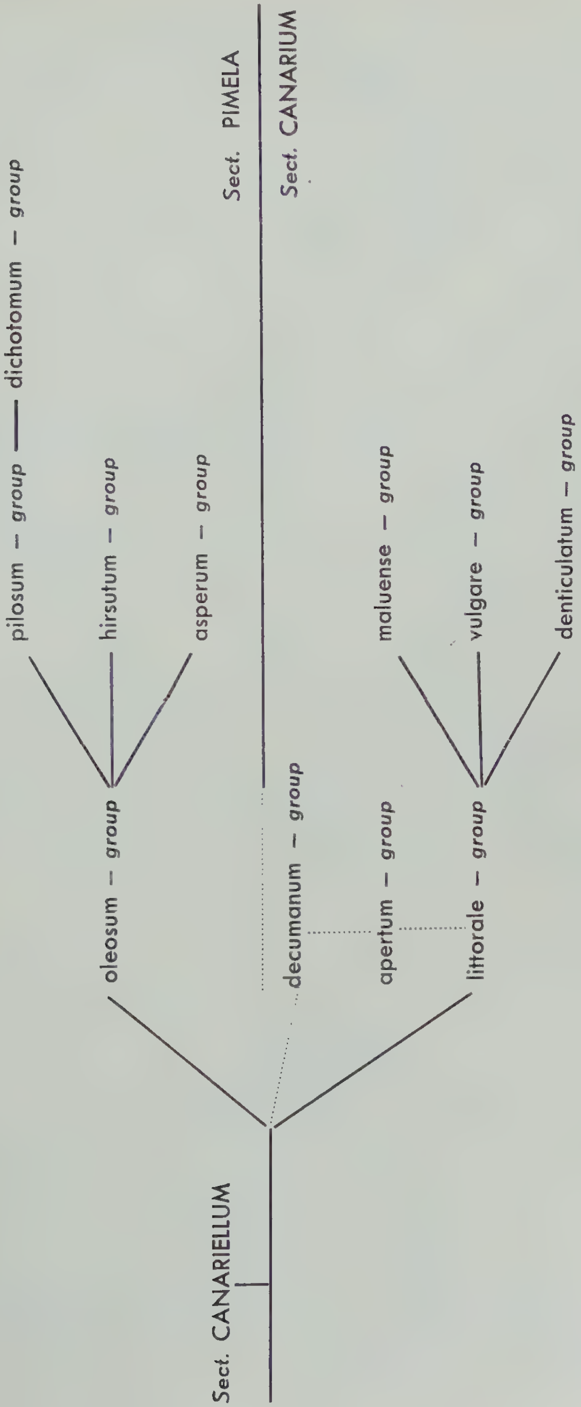


Fig. 3. A scheme of the relationships between the different sections and groups in *Canarium*.

free, in '♀' flowers not or hardly reduced. Disk annular, 6-lobed. Pistil sessile, 3-celled, in '♂' flowers only slightly reduced. Fruits with fleshy pericarp; pyrene with 3 fertile cells.

The main tendencies, realised in all or most of the sections, are:

1. the formation of stipules;
2. an increasing development of unisexual flowers, specially by the reduction of the pistil in the ♂ ones.

Other tendencies are mainly restricted to one of the sections, and will be dealt with under the section concerned.

A. Sect. Canarium

The type of this section differs from the generic type in the following points:

1. The presence of true stipules (Lam's '*metastipulae*'), which within the *Burseraceae* is a unique character. 'Metastipules' are absent only in the *apertum*-group, the taxonomical position of which is somewhat puzzling, but which seems not to be very primitive.
2. The presence of pseudo-bracts, homologous with the stipules, as far as known in contradistinction with all other members of the family.

The main tendencies of this section are:

1. development of axillary inflorescences into terminal ones;
2. reduction of the epipetalous stamens;
3. excavation of the receptacle of ♀ flowers, in which case the disk is for the greater part becoming adnate to the receptacle and the pistil is developing a 'pseudo-gynophore'.

Comparing the above facts with those of the other sections it will be found, that as a whole the present section is the one most deviating from the generic type. For convenience sake, however, and since it was considered undesirable to start with a group of such uncertain relationships as sect. *Canariellum,* I preferred the sequence given here.

a. littorale-group. *Fig. 4.*

This group seems to be the most primitive one of sect. *Canarium*; its type nearly coincides with that of the section; it can be defined slightly more exactly, however, in the following points:

1. the stipules are inserted at the conjunction of petiole and branchlet; they are roundish, small, and early caducous;
2. the pistillode in the ♂ flower is still rather large, and provided with a slender style-remnant, and with small cells with sterile ovules.

None of the species of this group fully coincides with this type; closest to it is *C. littorale,* which mainly differs by its terminal inflorescences.

C. littorale is one of the most variable species of the whole genus. It cannot be sharply subdivided into infraspecific taxa, consequently only the status of forma has been given to the more extreme examples of those morphological tendencies, which are also more or less geographically defined. All these extreme forms gradually pass into a group of mainly Sumatran specimens, which seems to represent the more original form of the species

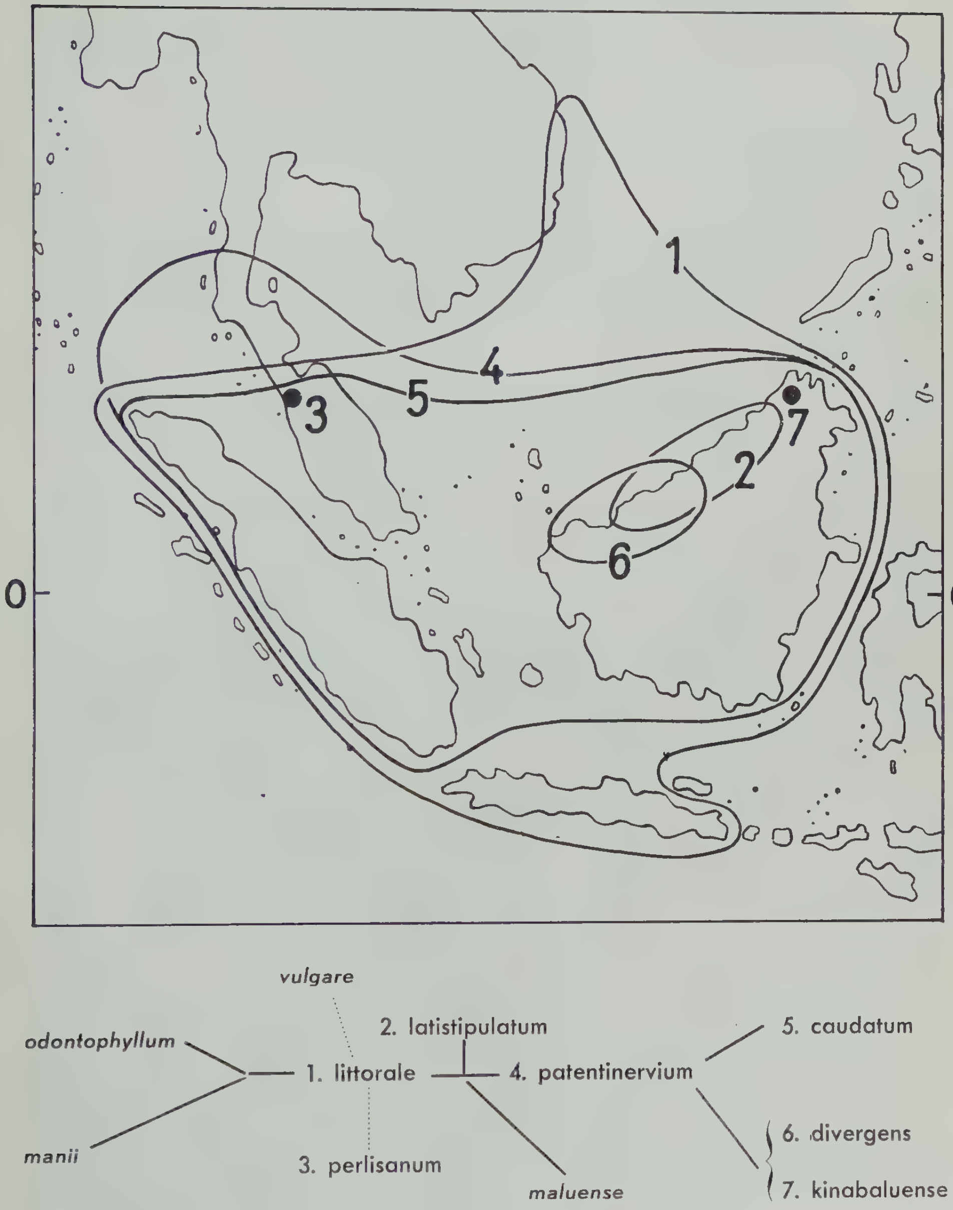


Fig. 4. *littorale*-group (in this and the following schemes unnumbered specific epithets in italics refer to related species, which are included in other groups).

(and which differs only very slightly from the Javanese f. *littorale*). The more extreme forms and the tendencies they represent are:

f. *purpurascens:* close to the basic form, margin of the leaflets more coarsely incised, lower side of the leaflets glaucous waxy; weakly developed in Sumatra (*C. glaucum*), well distinguishable in the Malay Peninsula (*C. purpurascens*), extremely developed in Annam.

f. *pruinosum:* a well distinguishable local group, related to the foregoing one; leaflets densely dentate throughout the margin, slightly bullate, white-waxy beneath; restricted to Borneo.

f. *tomentosum:* stipules slightly larger, leaflets more coriaceous, bullate, densely and minutely tomentose beneath, nervation strongly prominent on lower side; in Sumatra and the Malay Peninsula (*C. secundum*) merging into the central form, in Borneo well developed; particularly related to the next form.

f. *rufum:* differing from the preceding form mainly by its coarser leaves and inflorescences, its larger and more permanent stipules, its dentate leaf-margins, and the absence of a pistil-remnant in the ♂ flowers; in Sumatra not sharply delimited against the foregoing form, best developed in the Malay Peninsula. On the other side, this form seems to be rather closely related to *C. odontophyllum* — specially the Sumatran f. *odontophyllum* — and consequently to the base of the *denticulatum*-group.

C. latistipulatum and *perlisanum* seem to be marginal endemics, in Borneo and the Malay Peninsula resp., closely related to *C. littorale*. *C. perlisanum* is interesting by the presence of axillary inflorescences and connate stamens (both unique phenomena in this group and very rare even in the section) and by the stipules, which are inserted on the petiole; the taxonomic position of this species, which is known from one specimen only, is not quite certain, however.

C. patentinervium again seems to be directly connected with the basic group of *C. littorale* (some intermediate specimens are known). As a whole it seems to be slightly more derivative: it is much less variable and the much smaller number of secondary nerves seems to be caused by the reduction of part of them (these reduced secondary nerves are well distinguishable from strongly developed tertiary ones); it seems to be important as the basis of a group of species, characterized by entire leaf margins and shining lower side of the leaflets.

C. divergens and *kinabaluense* are marginal endemics, closely related to *C. patentinervium*.

C. caudatum is closely related to *C. patentinervium* (part of the ♀ specimens, especially from the Malay Peninsula, cannot with certainty be placed in one of the two species), it is distinctly more derivative by its 3-staminate ♂ flowers and by the tendency of the stipules to become auricle-shaped, more permanent, and inserted on the petiole (this tendency is especially developed in f. *auriculiferum*, which is mainly Bornean).

Finally, *C. maluense* ssp. *borneense*, the basic form of the *maluense*-group, in E. Borneo, is doubtless very closely related to *C. patentinervium* and *caudatum*.

Geographically, the centre of this group is apparently Sumatra, from where it radiated to the Malay Peninsula, Indo-China, Borneo, and Java.

Recent speciation seems to be chiefly marginal (the more advanced *denticulatum*-group apparently arose in Sumatra, however), whereas the central group retained its full variability and plasticity. The last-named fact remains rather puzzling. On the one side *C. littorale* seems to be rather close to the basis of a section that succeeded in extending its area to both West Africa and the Samoa Islands, and in developing such an extreme form as *C. schweinfurthii*, which thus apparently arose rather a long time ago; on the other side *C. littorale* looks rather like a young species, rather variable, especially in its geographical centre, and gradually developing some morphological tendencies towards the margins of its area. The extreme results of these tendencies, however differing mutually, cannot be sharply delimited against the central form. I cannot but conclude that *C. littorale* changed only very little during a very long time, that it remained in its original position, and that, on account of the relative stability of the climatological and other ecological conditions it lost only very little of its original gene-composition. Therefore, this widely distributed and common species possibly almost represents the trunk of a genealogical tree.

b. maluense-group. *Fig. 5.*

This group is connected with the *littorale*-group by *C. maluense* ssp. *borneense*, a taxon which on the one hand is very close to *C. maluense* ssp. *maluense*, seems to be more primitive, especially in its stipules and in the very slight reduction of the pistil in the ♂ flower; in both these characters it agrees with the basic species of the *littorale*-group. On the other hand it is rather alike *C. patentinervium* and *caudatum*, moreover, it is the only form of the *maluense*-group west of Macassar Strait. In my opinion it is the link between the *littorale* and the *maluense*-group, and the basic form of the latter.

The main morphological tendencies within this group are:

1. the stipules tend to become auricle-shaped, more permanent, and inserted on the petiole;
2. suppression of the epipetalous stamens;
3. two of the three fruit-cells become sterile, undergoing a rather strong reduction and being sometimes more or less shifted towards the periphery.

C. maluense is the central species, rather variable, and with a wide distribution (E. Borneo—New Guinea); f. *celebicum* is close to ssp. *borneense*, differing principally by the strong reduction of the pistillode (Lam, 1932b, cited part of these specimens under *C. littorale*!). The tendencies cited above are more or less incompletely realized already in the different forms of this species, thereby suggesting some evolution from west to east; f. *maluense* and *montanum* still show rather primitive characters, f. *lian* is intermediate, and f. *quadrangulare* is in all respects the most advanced one, with auricle-shaped stipules, some reduction in the number of stamens, and the sterile fruit-cells usually fully peripheral. This form of the Vogelkop Peninsula is very closely related to *C. sylvestre* (Moluccas and New Guinea), a much less variable species with often 3-staminate flowers and strongly reduced fruit-cells. *C. piloso-sylvestre* is a local endemic, differing in some minor characters only from *C. sylvestre*.

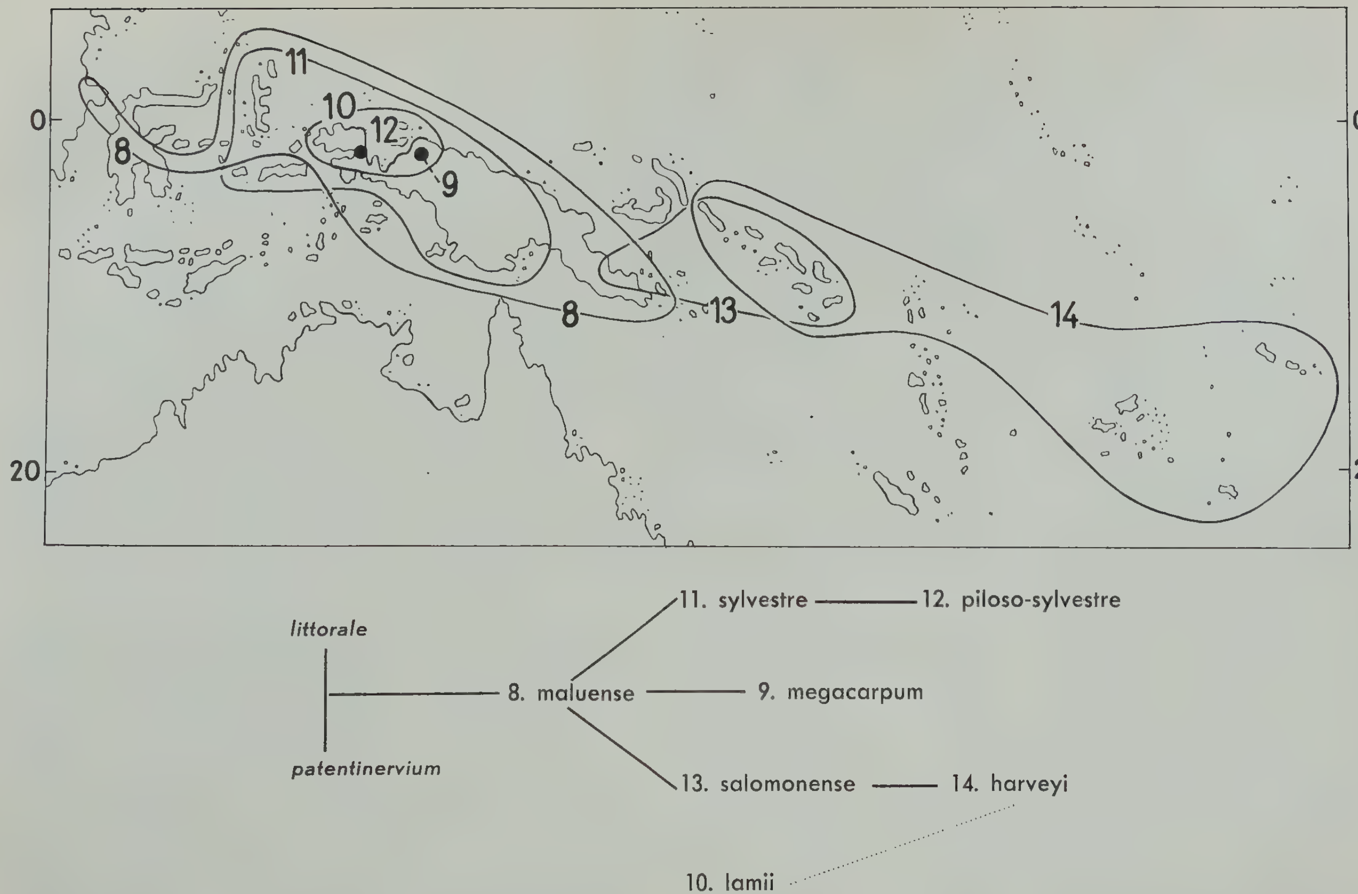


Fig. 5. *maluense*-group.

C. salomonense and *C. harveyi*, probably also the insufficiently known *C. lamii* and *C. megacarpum*, are pretty close to *C. maluense* f. *maluense*; they are all slightly more specialized in some flower and fruit-characters. *C. salomonense* comprises two subspecies, the more western of which, ssp. *papuanum* (E. New Guinea) shows a fruit of a slightly more advanced structure and is apparently more derived than the ssp. *salomonense* from the Solomon Islands. *C. harveyi* comprises in the various groups of islands some varieties, which are each specially characterized by their fruits; these different fruit-forms can not be arranged in a distinct continuous series.

C. megacarpum and *lamii* are still very incompletely known Papuan endemics, which apparently belong to this group.

Geographically this group ranges from East Borneo to the Samoa Islands with New Guinea as its main centre of speciation.

c. vulgare-group. *Fig. 6.*

The main series of this group is formed by the species *C. vulgare — indicum — kaniense.* Within this series the main tendencies are:

1. the stipules, which are inserted at the conjunction of petiole and branchlet, and are rather caducous, entire, and up to 5 cm long in *C. vulgare,* tend to become more permanent, toothed to fimbriate at the margin (especially so in *C. kaniense* var. *globigerum*), and larger (up to 12 cm in *C. indicum* var. *platycerioideum*); rarely they are inserted on the base of the petiole;
2. all parts (branchlets, leaves, inflorescences, flowers, and fruits) tend to become coarser.

Again, as in the *maluense*-group, we see that the most western species — in the present group this is *C. vulgare* — is morphologically the form least deviating from the type of the section. It may be supposed that *C. vulgare* also rests upon the *littorale*-group, though the connection is less clear.

C. indicum is doubtless very closely related to *C. vulgare* (these two species are almost vicariads!) and differs mainly by its more specialized stipules and its coarser habit; its var. *platycerioideum* is an extreme local form from the Vogelkop Peninsula. *C. kaniense* is closely related to *C. indicum,* slightly more specialized in its stipules and its fruits; its var. *globigerum* is again an extreme local form.

The relationships of the Philippine species *C. luzonicum* and *ovatum* are not quite clear. In some respects they seem to be intermediate between the *littorale*-group — especially *C. luzonicum* shows, for instance in its stipules, distinct affinities to that group — and the *vulgare*-group. On the other hand they are both characterized by axillary inflorescences, which are supposed to be more primitive than terminal ones, and which are rare in the *littorale*-group and absent in the *vulgare*-group. In addition, *C. luzonicum* shows some tendency to reduction of the number of stamens in the ♂ flowers, whereas *C. ovatum* is distinguished by its unusual kind of stipules. Apparently, these two species have been isolated for rather a long time. As far as I can see there are three explanations possible for their descendance: 1e. they are descendants of a population which some time connected the *littorale*-group and the *vulgare*-group via the Philippines; 2e. the connection between the *littorale* and the *vulgare*-group was brought about directly from Borneo to Celebes (near *C. vulgare*), and thus they may perhaps be derived from ancestors of the *vulgare*-group; or, 3e, they may represent an independent line, issued from the *littorale*-group more or less parallel to the *vulgare*-group.

Geographically speaking, the last-named group shows a distinct trend from west (Bawean, Celebes) to east (New Hebrides), the link with W-Malaysia being established either via the Philippines or directly across the Macassar Strait.

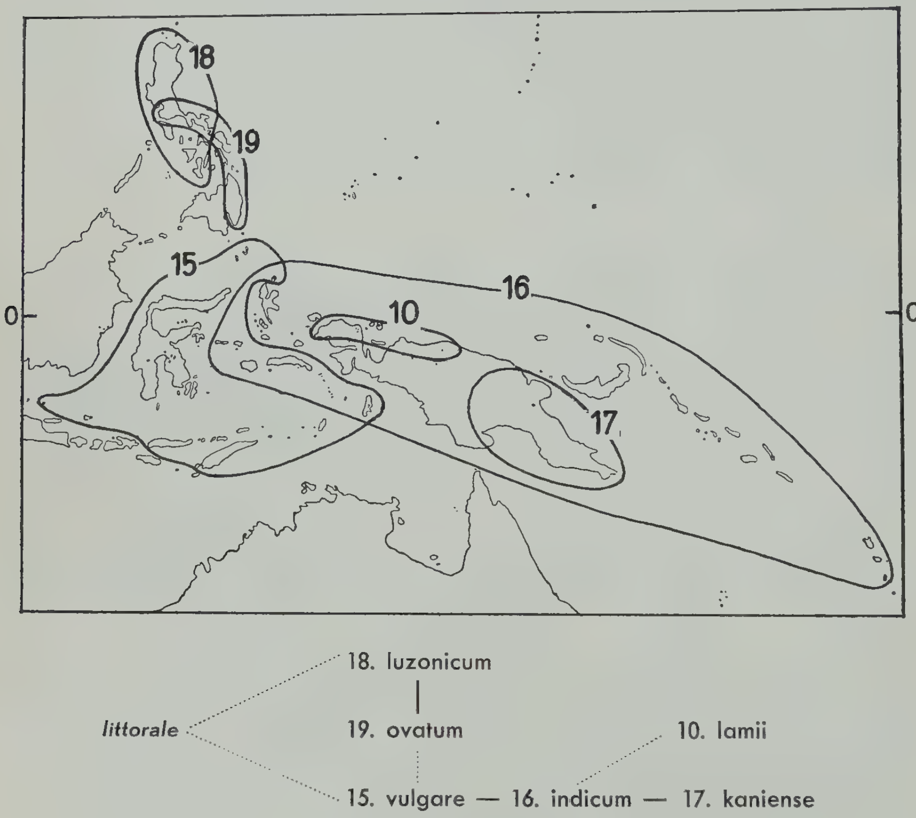


Fig. 6. *vulgare*-group.

d. denticulatum-group. *Fig. 7.*

This is doubtless one of the most interesting groups of the genus, especially geographically. It comprises two series, the first of which consists of *C. odontophyllum, denticulatum, karoense,* and *megalanthum*, the second of *C. manii, zeylanicum, paniculatum, madagascariense,* and, to all probability, also *C. schweinfurthii.* Both series have apparently originated somewhere in the *littorale*-group. They show a high degree of parallelism in the development of many flower and fruit-characters. As to the stipules

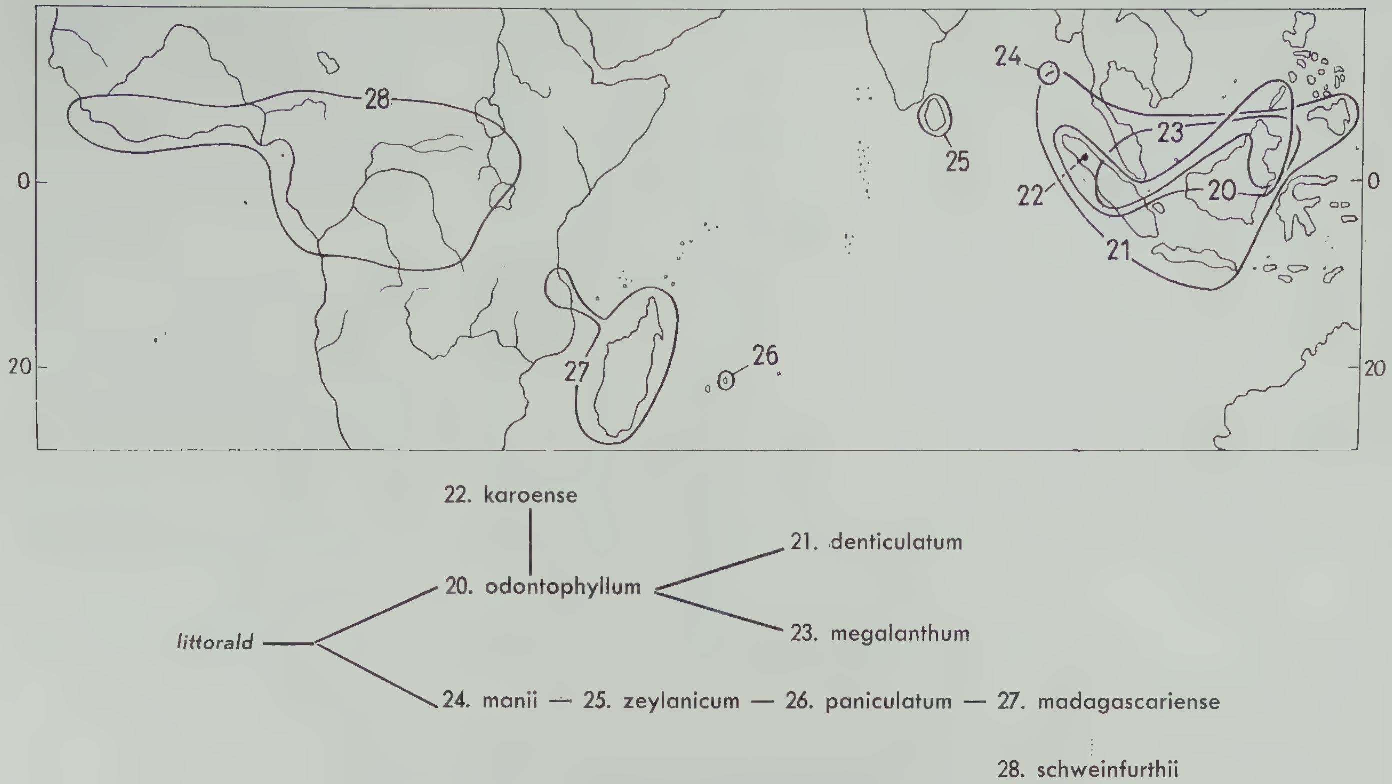


Fig. 7. *denticulatum*-group.

and the position of the inflorescences, and also geographically, both series developed along diverging lines, however.

The first series is characterized by axillary inflorescences and by a tendency towards less caducous, incised stipules; it spread mainly throughout W. Malaysia. Its basic species is probably *C. odontophyllum*, and more particularly the least specialized form of that species, f. *odontophyllum*. This form is very close to *C. littorale* f. *rufum*, its stipules being less specialized than in any other representative of the series, and the presence of a pistillode in the ♂ flowers is a primitive character, which is also lacking in all the other species. Forma *odontophyllum* is known from Sumatra and Borneo. *C. odontophyllum* f. *multifidum* lacks the pistillode in the ♂ flowers, and has much more specialized stipules which are less caducous, rather big, and deeply fimbriate along the margin. The last-named form is known from N. and E. Borneo; intermediates have been collected in N. and E. Borneo, and Palawan.

C. denticulatum is undoubtedly very close to *C. odontophyllum*, though distinctly more different from *C. littorale* f. *rufum* than that species, and therefore perhaps more advanced. It mainly differs from *C. odontophyllum* in the following points:

1. stipules pectinate;
2. pistillode in ♂ flowers usually fully reduced;
3. the margin of the leaflets is less dentate, the leaflets are less pubescent, and the nervation is less prominent.

As a whole, *C. denticulatum* f. *denticulatum* seems to be most closely allied to *C. odontophyllum*, though in the leaf-characters mentioned above *C. denticulatum* ssp. *kostermansii* comes closer to the last-named species. The position of the E. Bornean ssp. *kostermansii* is not quite clear; as it apparently shows a rather high degree of independence, a subspecific rank was proposed for it. Forma *denticulatum*, the least specialized of the two forms of ssp. *denticulatum*, has the larger area: W. Malaysia (though apparently rare in Borneo), S. Andaman, Burma, Basilan, and Mindanao; f. *fissistipulum* seems to be more specialized as to the characters mentioned above and is restricted to Sumatra, Banka, and Borneo (where it is the more common form).

C. megalanthum (Sumatra, Malay Peninsula, and Borneo) and *C. karoense* (Sumatra) are two species, which are closely allied (possibly even conspecific) and which undoubtedly belong to the relationship of *C. denticulatum*; they are different in some characters of minor importance only.

The second series is characterized by (mainly) terminal inflorescences and by caducous, entire stipules; in both characters it comes even closer to the recent representatives of the *littorale*-group than the first series. Furthermore, the pistillode in ♂ flowers is absent, and the receptacle in ♀ flowers is distinctly concave. This group developed in a western direction, its representatives being known from the Andamans to W. Africa. *C. manii* (Andamans), *C. zeylanicum* (Ceylon), *C. paniculatum* (Mauritius), and *C. madagascariense* (Madagascar and E. Africa), all mutually closely allied, represent a line of gradual development, both morphologically and geographically.

C. schweinfurthii (W. Africa) is in some respects one of the most interesting species of the genus. Though it seems to be more closely allied to *C. madagascariense* than to any other species of the genus, it differs from the last-named species in some important characters, some of which are even unique in the genus. On the one hand it seems to be primitive by its axillary inflorescences and by the occasional presence of a distinct pistillode in the ♂ flowers; its strongly developed stipules, the deeply concave receptacle in the ♀ flowers, and the androphore in the ♂ flowers, on the other hand, rank it among the most highly developed species of the whole genus. It is restricted to the rain-forest belt of West and Central Africa, and must have been isolated for a very long time.

e. apertum-group. *Fig. 8.*

This group consists of 3 species only, which are closely related mutually. Their taxonomical position in the genus is far from clear. The most important characters of this group are:

1. no stipules; bracts lanceolate to subulate;
2. inflorescences terminal;
3. petals unguiculate (this character is unique in the genus);
4. pistil (as far as known) always stalked (pseudogynophore); pistillode in ♂ flowers absent;
5. large fruits.

The group is West Malaysian; *C. pseudopatentinervium* and *grandifolium* are very local endemics.

The general habit, the characters 2, 4, and 5 mentioned above, as well as the geography, more or less point to a relationship with sect. *Canarium*. On the other hand there is an indubitable resemblance to the *decumanum*-group, with which it moreover agrees in the characters 1, 4, and 5 just mentioned, as well as in a similar branch-anatomy (pith with only a peripheral cylinder of many small, sclerenchymatic vascular strands). Therefore it remains undecided whether the present group is more allied to the *decumanum*-group, and evolved parallel to sect. *Canarium* in some characters, or whether its resemblance to the *decumanum*-group is due to a parallel evolution within sect. *Canarium*.

f. decumanum-group. *Fig. 8.*

The relationships of this group, which consists of a pair of vicarious species, is obscure. At first sight both species show a distinct resemblance to sect. *Canarium*, and specially to its *apertum*-group. On the other hand, however, the *decumanum*-group possesses some unique characters of its own (especially the kind of stipules in *C. decumanum*, which is furthermore known only from the genera *Garuga* and *Dacryodes*) which are generally assumed to be primitive. It also shows in its vegetative characters some superficial resemblance to sect. *Canariellum* (which is supposed to represent a relic-group). Geographically, the two species are typical vicariads, *C. decumanum* being East Malaysian, *C. pseudodecumanum* West Malaysian, the demarcation apparently lying somewhere in E. Borneo (in the Philippines both species are absent).

Summarizing, this small group may represent an early independent segregate, which has taken its own course for a long time, either without succeeding in producing more species, or the gap between the present group and other species derived from it became so wide that it is difficult now to recognize the *decumanum*-group as their indirect ancestors.

Looking back on sect. *Canarium* as a whole, the basis is apparently represented by the *littorale*-group, more in particular by *C. littorale* and *patentinervium*, its possible centre of origin being W. Malaysia. Direct derivatives are the *maluense*-group, distributed eastward to Samoa, and the *denticulatum*-group, developing to the west and reaching Africa, avoiding, however, continental Asia. Doubtless related is also the *vulgare*-group, which also developed eastward as far as the New Hebrides. Possibly the West Malaysian *apertum*-group is related to the *denticulatum*-group, but the position of this group as well as that of the probably related *decumanum*-group remains uncertain.

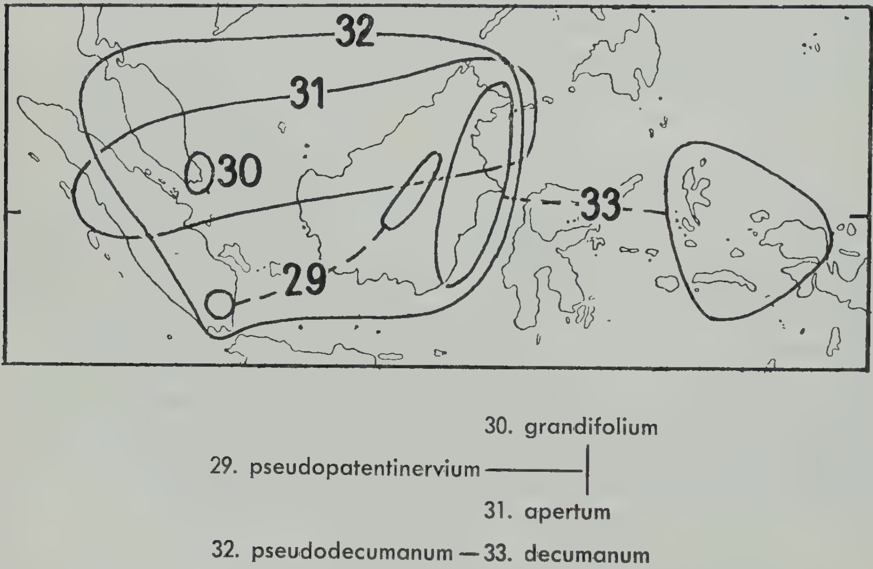


Fig. 8. *apertum-* and *decumanum*-groups.

B. Sect. Pimela

The type of this section fully coincides with that of the genus, which means that the present section seems to be less derived than sect. *Canarium*. It cannot be considered to represent the direct forerunner of the latter, however, though it has taken its own way, as may be clear from the main tendencies realized in this group, which are:

1. the formation of pseudo-stipules, in all probability homologous with the petiolules of a pair of reduced leaflets;
2. some tendency towards terminal inflorescences, though these are much less common than in sect. *Canarium*;
3. in some groups a tendency towards racemose, rarely even spicate, inflorescences (especially the ♀ ones);

4. a rather strong tendency towards connate stamens;
5. the absence (mostly) of a pistillode in ♂ flowers.

g. oleosum-group. *Fig. 9.*

It is hardly open to doubt that this group comes closest to the type of sect. *Pimela.* All its species lack stipules, possess axillary inflorescences, and their stamens are free or only slightly connate. Moreover, *C. oleosum* is the only species of the whole section with a well-developed pistillode with style-remnant in the ♂ flowers. On the other side, in some characters — reductions in the fruit, ♀ flowers with a slightly concave receptacle — *C. oleosum* seems to be more advanced than the closely related *C. balsami-*

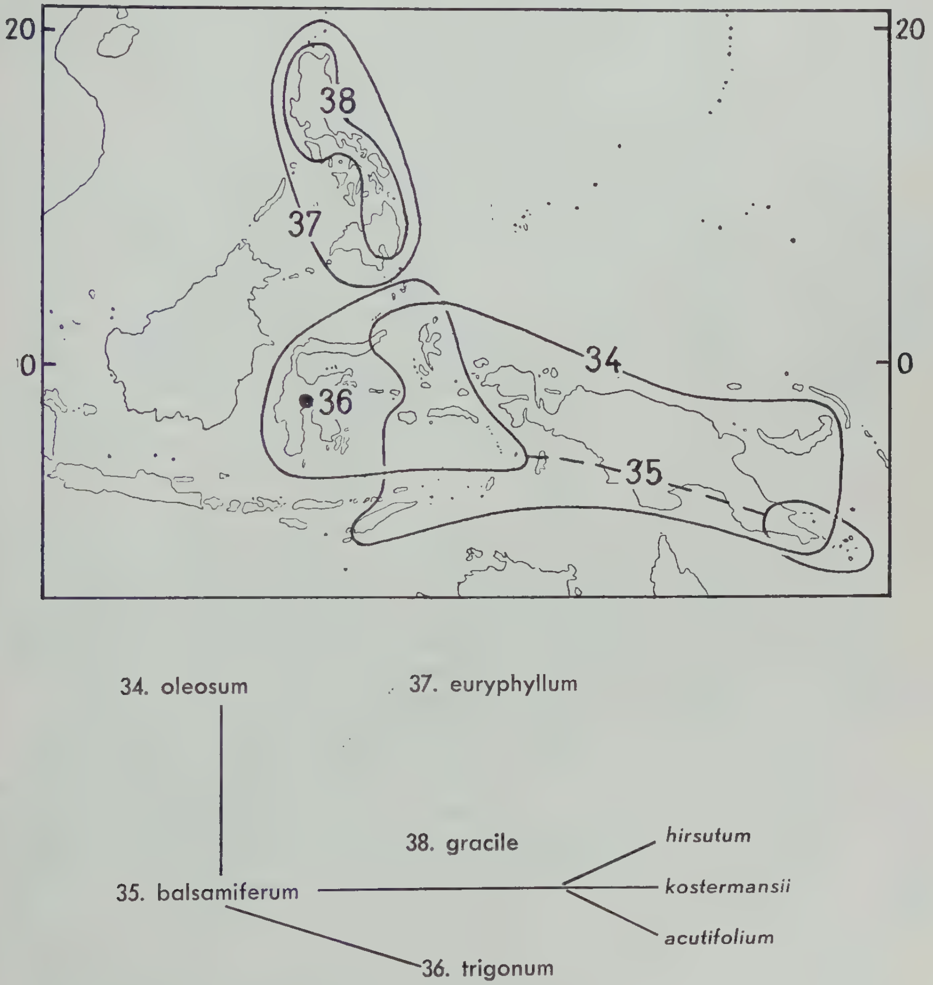


Fig. 9. *oleosum*-group.

ferum. Both are distributed over most of E. Malaysia. *C. trigonum*, slightly differing from *C. balsamiferum*, particularly in its fruits, is a local endemic, known only from Central Celebes.

C. euryphyllum and *gracile* may represent rather strongly specialized Philippine species of this group. *C. euryphyllum* is particularly variable in its vegetative characters (the more pilose and rather uniform var. *ramosii* is restricted to the eastern part of the specific area and, in addition, shows in its flowers, fruits, and leaves some resemblance to *C. hirsutum*). *C. gracile* is very constant, morphologically rather isolated (particularly by the quite unusual development of the disk in the ♂ flowers, and by its fruits) and could possibly also form part of the *pilosum* or the *dichotomum*-group (related to *C. merrillii* and *pimela*?).

An interesting point is the concentration of the three main species of this group in E. Malaysia, especially Celebes, from where it apparently mainly spread to the east, possibly also to the Philippines (*C. euryphyllum* and *gracile*). Moreover, this group seems to be connected with the *pilosum*-group (the possibly most primitive species of this mainly West Malaysian group being *C. kostermansii* in E. Borneo), the *hirsutum*-group (the centre of which seems to be the Moluccas, as will be discussed below), and the *asperum*-group (some relationship between *C. balsamiferum* and *C. vrieseanum* from Celebes and Mindanao, the last-named species perhaps being the basic species of the group; moreover, the most primitive variety of the furthermore Papuan *C. acutifolium* is also an endemic of Celebes!).

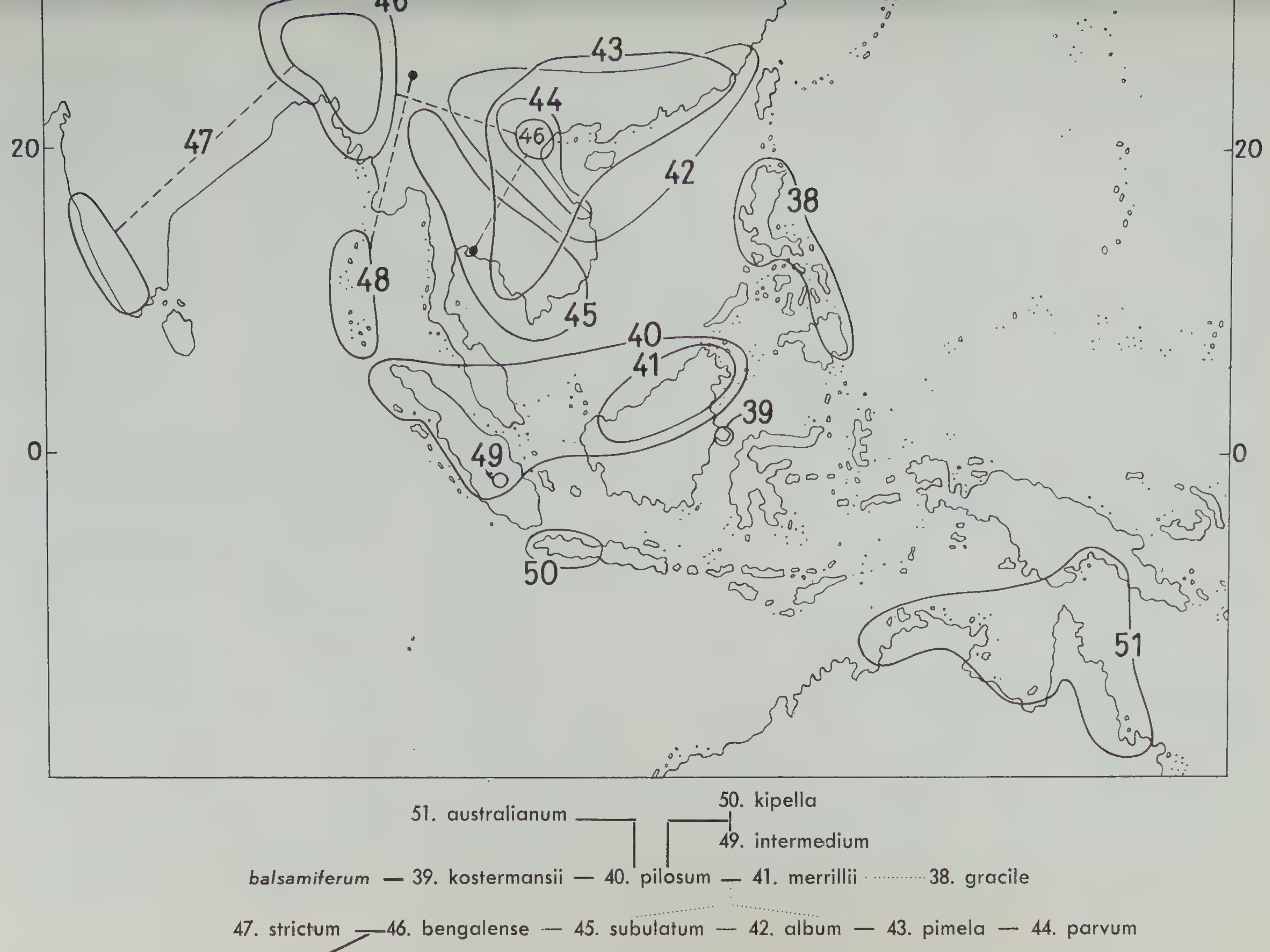
h. pilosum-group. *Fig. 10.*

This group seems to be slightly more advanced than the *oleosum*-group in the following characters:

1. the presence of stipules in most of the species; apparently, these tend to be shifted up the petiole and to be reduced. The absence of stipules in part of the species, particularly in *C. pilosum* ssp. *borneense*, in *C. pimela* and *parvum* (in the closely allied *C. album* they are present, though very caducous), and in the greater part of the specimens of *C. strictum* seems to be secondary;
2. the inflorescences distinctly tend to become terminal in *C. pilosum* and in *C. merrillii*; in both of these species truly terminal inflorescences are rare, but it is interesting to note that in *C. merrillii* the inflorescences are often only seemingly terminal, since the terminal vegetative bud is very small and only develops after flowering, the infructescences being distinctly axillary;
3. the stamens are nearly always distinctly connate, often more than half way up.

The group is mainly developed in W. Malaysia and continental Asia, with the exception only of *C. australianum*, but the taxonomical position of that species is not quite clear.

As a whole it is difficult to say something on relative primitiveness in this group on morphological grounds only, since either the differences between the species refer to comparatively unimportant characters (from a typological viewpoint), or it is difficult to say, whether a 'primitive' character is primary or secondary. The relationships between the individual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51. australianum
50. kipella
49. intermedium
balsamiferum — 39. kostermansii — 40. pilosum — 41. merrillii .... 38. gracile
47. strictum —46. bengalense — 45. subulatum — 42. album — 43. pimela — 44. parvum
48. euphyllum

Fig. 10. *pilosum*-group.

species seem to point to *C. pilosum* as the central species; geographically also this seems to be very well possible.

C. kostermansii (E. Borneo) is doubtless rather closely related to *C. pilosum* though it is perhaps slightly more primitive in some characters. Moreover, it also shows some resemblance to *C. vrieseanum* and *balsamiferum*, which might mean that it may represent a link between the *pilosum*-group and the *oleosum*-group.

C. pilosum ssp. *borneense* may be slightly more derived in some characters than ssp. *pilosum*; it is distinctly related to *C. merrillii*, also in Borneo.

C. album seems to be rather closely related to *C. merrillii* or *pilosum* on the one side, on the other it is undoubtedly very close to *C. pimela* and *parvum*, which seem to be somewhat more derivative in some characters, especially in the absence of stipules (all Indo-China and S. China).

C. subulatum is morphologically as well as geographically interrelated between the E. Asiatic *pilosum*-like species (*album*, *pimela* and *parvum*) and the S. Asiatic *strictum*-like ones (*bengalense*, *strictum*, and *euphyllum*). Perhaps we may consider this species the link between the continental Asiatic species of the present group and the W. Malaysian ones. If this should be true, the resemblance between *C. merrillii* and *C. album* might be due to parallel development.

C. bengalense, *strictum*, and *euphyllum* are a group of mutually closely related species; *C. bengalense* is possibly slightly less specialized than the other species; *C. euphyllum* seems to have been isolated for a fairly long time.

C. intermedium and *kipella* are local endemics (of S. Sumatra and W. Java respectively), closely related mutually and again distinctly related to *C. pilosum*.

Summarizing, it may be that the group originated in E. Malaysia, somewhere near *C. balsamiferum*, that it developed towards the east (*C. australianum* being its last representative there) and, in some way crossing Macassar Strait, also towards the west. In W. Malaysia it developed it first centre of speciation with *C. pilosum* itself as the central species. From here it invaded the Asiatic continent, in view of the central position of *C. subulatum* in this part of the area probably via the Malay Peninsula and then migrated to the west as far as the S. Deccan, and to the N.E. to S. China and Hainan. As is obvious from the above reflections on the relationships of the individual species, this picture, however plausible, is of course very hypothetical, even more so than that given for most of the other groups.

i. dichotomum-group. *Fig. 11.*

This group comprises only two species, *viz. C. dichotomum* and *fuscocalycinum*; these two species seem to be rather closely related, and may furthermore be allied to the *pilosum*-group. With the latter they have in common the often high-connate stamens and the tendency towards terminal inflorescences (which in the *dichotomum*-group is fully developed); furthermore the present group is restricted to W. Malaysia, which is also the main centre of the *pilosum*-group. It might be inferred that the *dichotomum*-

group is derived from the same ancestral form as is the *pilosum*-group. In some characters (especially the terminal inflorescences) it seems even to be slightly more advanced; the relationship seems to be insufficient, however, for including the two species in the *pilosum*-group.

C. dichotomum is the more common and more widely spread of the two species (Sumatra, Borneo); *C. fusco-calycinum* is a local endemic of Sarawak.

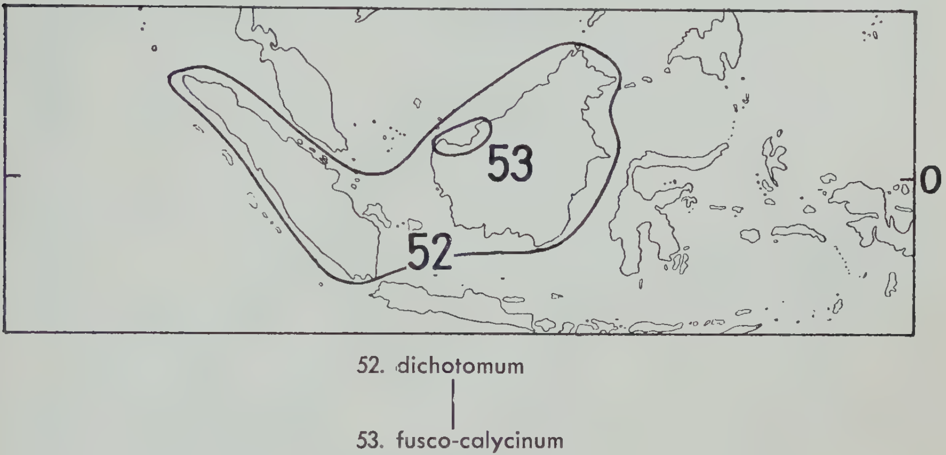


Fig. 11. *dichotomum*-group.

j. hirsutum-group. *Fig. 12.*

The types of this group and of the section as a whole nearly coincide, which may indicate that the present group is probably a relatively primitive one. The only uncertainty is whether the absence of stipules in some of the species should be considered primary or secondary; in my opinion at least in some of them (especially in some varieties of *C. hirsutum*) it may very well be a primitive character.

The very variable and widely spread *C. hirsutum* is here supposed to be the central species of this group, and the one which comes nearest to the type. The greatest variability of this species is to be found in the absence or presence of stipules and in the fruit-kernel. On account of the last-named character the species has been subdivided into two subspecies and on account of the stipules both subspecies have been subdivided again into two varieties. The distribution of the infraspecific taxa is interesting: the form with the least specialized fruits, f. *hirsutum*, is restricted to the Moluccas; both subspecies overlap in the Moluccas only, the one — ssp. *multicostulatum* — extending eastward, the other — ssp. *hirsutum* — westward. The exstipulate varieties of both subspecies are found near the Moluccan centre (the one, var. *multicostulatum*, in the Moluccas, the other, var. *beccarii*, in Celebes; the last-named variety is rather aberrant and may even represent a distinct species). Finally, in both directions just mentioned there is a rather distinct evolution of some characters. It may be assumed that the eastern series had its centre of speciation in New Guinea, giving rise to *C. hirsutum* var. *leeuwenii, C. rigidum, polyphyllum,* and *cestracion,* all characterized by irregularly grooved fruit-kernels; furthermore, most of these species have exstipulate leaves with the exception only of *C. hirsutum* var. *leeuwenii* and *C. cestracion.* (Since the latter possesses very small, caducous stipules and is doubtless very closely related to *C. polyphyllum* and *rigidum,* it remains to be considered whether the absence of stipules in the two last-named species is really a primitive character). Specializations of this series are the high-connate stamens, the absence of a pistillode, and the strongly thickened upper half of the petals, all found in *C. rigidum* and *polyphyllum* (the flowers of the closely related *C. cestracion* are still unknown).

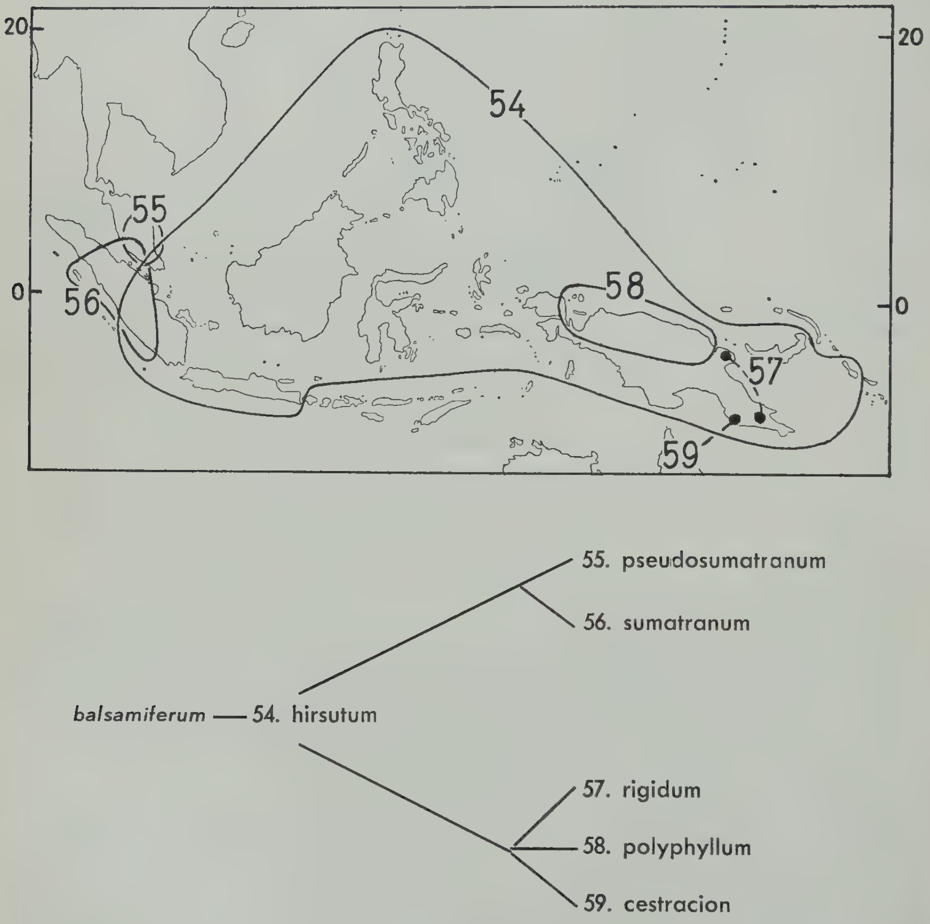


Fig. 12. *hirsutum*-group.

The western series found its first centre of diversity in the Philippines. Some forms with highly specialized fruit-kernels developed here; the least specialized of these, f. *scabrum*, which is closest to f. *hirsutum*, is the only one which reached W. Malaysia, possibly via the Philippines. At the very boundary of the group-area, a secondary centre of speciation has developed in Sumatra and the Malay Peninsula, which has given rise to *C. sumatranum* and *pseudosumatranum*. The specializations of these species are not very different from those at the eastern boundary of the area: the stamens are connate, the pistillode is fully suppressed, and *C. sumatranum* even possesses the same kind of strongly thickened petals. Here again one species, *C. sumatranum*, has no stipules (and again it seems questionable whether this character is primitive), whereas the other one has very caducous, small stipules.

The conclusion is that the *hirsutum*-group, which probably may be derived from the *oleosum*-group, developed from a centre in the Moluccas (an area which apparently also forms part of the centre of the *oleosum*-group) in two directions. It is interesting to note that the speciation is distinctly marginal, with a surprising parallelism in several specializations at both ends of the area.

k. asperum-group. *Fig. 13.*

The type of this group differs from the type of sect. *Pimela* in the following points:

1. subulate pseudo-stipules;
2. pistil in ♂ flowers strongly reduced;
3. 2 fruit-cells sterile and slightly reduced.

The two taxa which best match this description are *C. vrieseanum* and *C. acutifolium* var. *celebicum*. It is interesting that both of these show some affinities to *C. balsamiferum*, and that both occur in Celebes (the former also in Mindanao), which forms part of the area of the last-named species. This may imply that the centre of origin of the *asperum*-group coincides again with that of the *oleosum*-group.

C. vrieseanum, on the other side, shows already some of the general tendencies of the present group: narrowly thyrsoid to racemose inflorescences and slightly confluent stamens. This species seems neither to be very closely related to *C. acutifolium* nor to *C. asperum*.

C. acutifolium var. *celebicum* is doubtless the most primitive variety of this species; primitive characters of this variety as well as of var. *aemulans* in relation to var. *acutifolium* are the presence of 6 stamens, the permanence of pith in the branchlets, and the non-specialized stipules. In some other characters the Papuan var. *aemulans* seems to be more closely related to the equally Papuan var. *acutifolium*, which is characterized by hollow twigs, exceptionally long and thin stipules, 3 stamens, and small fruits with two strongly reduced sterile cells. The species as a whole is relatively primitive by the axillary, broadly thyrsoid inflorescences and the free stamens.

C. macadamii (New Guinea) seems to be closely related to *C. acutifolium*, is, however, still insufficiently known.

C. asperum is the central species of this group and the most variable one. The most primitive characters seem to be preserved in ssp. *papuanum*;

under this name are provisionally united at least three mutually more or less differing populations from different parts of New Guinea, all still insufficiently known. The main primitive character in relation to ssp. *asperum* is the thyrsoid inflorescence. The Philippine var. *clementis* is mainly characterized by a compoundly spicate inflorescence. Var. *asperum* doubtless is the most derived form — inflorescences nearly always racemose to even spicate —; it reached Borneo on the one side, New Guinea and the Solomon Islands on the other, and shows a great variability particularly in the vegetative characters, especially in the Philippines.

C. schlechteri (E. New Guinea and New Britain) which is rather closely related to *C. asperum*, seems to be slightly more derived by its confluent stamens which are slightly connate to the disk, and is furthermore characterized by its fruit.

The mutually closely related Melanesian species *C. chinare, vanikoroense, smithii, vitiense,* and *samoense* may be derived either from *C. asperum* or from *C. acutifolium* var. *aemulans.*

Summarizing, the most primitive forms of this group again show some relationship with the *oleosum*-group and are concentrated on Celebes. The main centre of speciation was apparently New Guinea, whereas *C. asperum* mainly evolved in a western direction, reaching as far as Borneo (perhaps via the Philippines) and Bawean and Kangean Island; in an eastern direction the group succeeded in reaching Samoa.

If now we review sect. *Pimela* as a whole, we find that the relationships of all its groups can be traced back to the *oleosum*-group and to Celebes and the Moluccas. Apparently we have to look here for the centre of the recent distribution of the section. Accordingly it is not surprising that 3 out of 5 groups are principally East Malaysian, and that both West Malaysian groups are the most advanced ones. It is certainly remarkable that these two western groups are unknown from the Philippines; the same is more or less true for the two eastern groups of the West Malaysian sect. *Canarium*, and both facts may point to a former possibility of a direct crossing of Macassar Strait (see, however, the *vulgare*-group).

Among the other 3 groups the *oleosum*-group is restricted to E. Malaysia (with probably 2 species in the Philippines); the other two groups are distributed from W. Malaysia to Melanesia, apparently crossing Wallace's line in the north via the (younger?) Philippine bridge.

C. Sect. Canariellum. *Fig. 14.*

It is not easy to state accurately the taxonomical position of this section, particularly as it seems to have been isolated for a very long time indeed. Part of its characters may be very primitive, part of them seem to be more derived than in any of the other sections. In my opinion, the following characters, in which the present section comes very close to the type of the genus, are really primitive:

1. the absence of stipules in all species;
2. axillary inflorescences in *C. muelleri* and sometimes in *C. baileyanum*;
3. in *C. baileyanum* apparently the flowers are more often truly

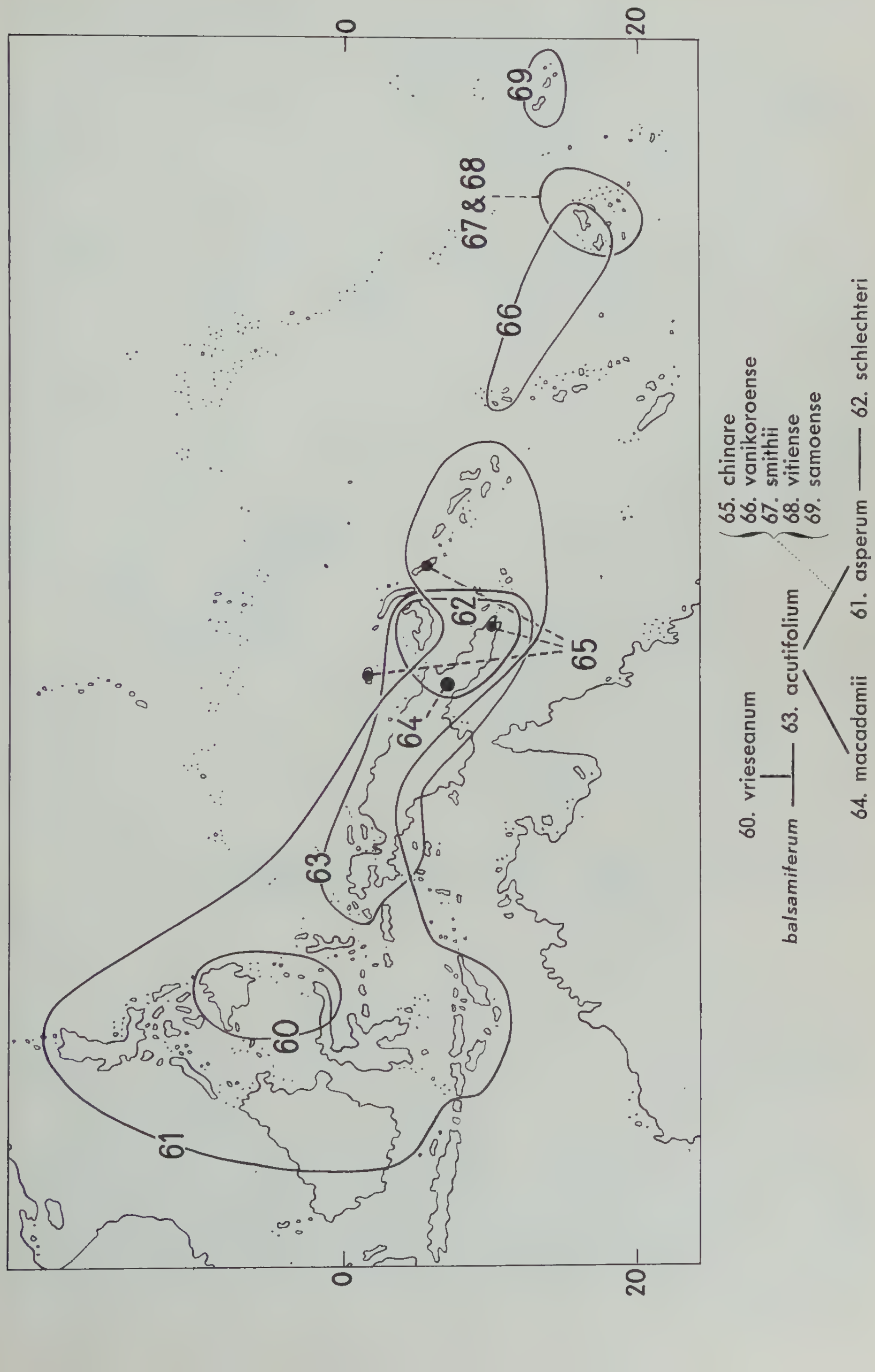


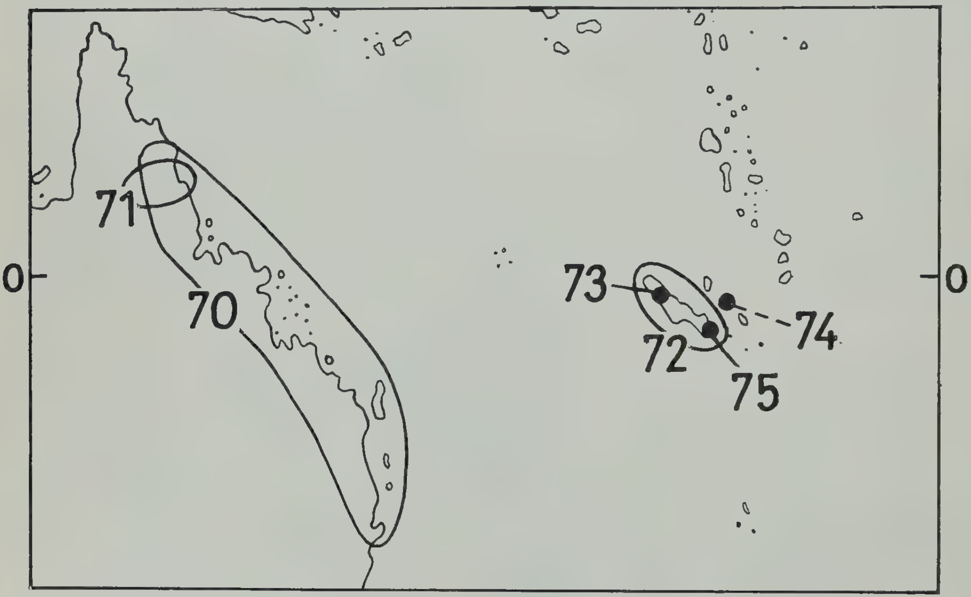
Fig. 13. *asperum*-group.

bisexual than in any other species of the genus; moreover, 4-merous flowers and fruits seem to be less rare in this species — and in the closely related *C. muelleri* — than in any other one.

For the rest, the flowers and fruits are like those of the type of the genus.

The most important tendencies seem to be:

1. the reduction of the number of ovary-cells, which in *C. oleiferum* and *whitei* is 2;
2. the apparent reduction of the vascular strands in the pith of the branchlets, a character which, as is discussed in chapter I, in all probability does not betray a primitive homology with related genera, but represents a secondary condition.



71. muelleri — 70. baileyanum — 72. oleiferum
73. trifoliolatum
74. balansae
75. whitei

Fig. 14. Sect. *Canariellum.*

The most interesting series of species in this section is formed by *C. muelleri* — *baileyanum* — *oleiferum*. The former two species, both restricted to N.E. Australia, are doubtless very closely allied; *C. muelleri* seems by its apparently always axillary inflorescences to be slightly more primitive than *C. baileyanum*, which has pseudoterminal to terminal inflorescences. The close relationship between these two species and the New Caledonian *C. oleiferum* apparently supports the idea of a relatively old age of this group, since a direct land connection between Australia and

New Caledonia is supposed to have been broken since the Eocene. *C. oleiferum* is in some characters more advanced than the two Australian species (pistil 2-merous, inflorescences exclusively terminal).

The other three species of this section, *C. trifoliolatum, balansae*, and *whitei*, all New Caledonian, are apparently very rare (each of them is once collected only as far as I know); they all seem to be rather isolated taxonomically.

Attempt towards a synthesis.

If now we review the genus as a whole we may come to the following picture, which with all its inherent shortcomings may well represent the best synthesis attainable on account of the available facts.

We have found that the genus can be subdivided into 3 distinct sections and the *decumanum*-group, the taxonomical position of which remains unsolved. Out of these three sections, the first (*Canarium*) — the apparently most derived one — is centred in W. Malaysia, all its tracks leading to Sumatra; the second (*Pimela*) is East Malaysian, its tracks apparently pointing to Celebes and the Moluccas as the main centre of radiation; the third (*Canariellum*), which, on account of its showing some relic-characters, seems to represent an earlier off-shoot, is restricted to N.E. Australia and New Caledonia, apparently having reached the last-named island from Australia.

The above facts point to the East Malaysian—North Australian area as the most probable centre of origin of the genus *Canarium*.

Whether the forerunners of *Canarium* — which must have been closely related to the ancestors of *Dacryodes*, and which in turn both must have evolved from the *Protieae* and accordingly may have had their centre of origin in S. America — reached E. Malaysia from the southeast (in which case the *Canarieae* might be of subantarctic origin), from the west (arriving together with *Dacryodes*), or directly from the east, remains unsolved.

Either after reaching E. Malaysia, or on its way to that landmass, sect. *Canariellum* branched off; this section performed a development of its own in Australia and New Caledonia, possibly from early tertiary times onward.

Shortly afterwards, sect. *Pimela* developed in the Moluccas and the genus proceeded to W. Malaysia, where sect. *Canarium* began its development. It does not seem quite impossible to me that the *decumanum*-group, which according to morphological as well as geographical facts seems to have been isolated for a long time, is a relic of the original link between E. and W. Malaysia.

Initially, the direct crossing of Macassar Strait apparently remained fairly well possible; the *pilosum*-group — possibly after splitting off *C. australianum*, and then centering in East Malaysia — proceeded to the west, where it probably soon gave rise to the *dichotomum*-group. After some considerable diversification it may, either via Borneo or the Malay Peninsula, have reached continental Asia, possibly first in the region of the Me-Kong and Me-Nam-basins, and from there spread both to the west and to the northeast. The *maluense*-group and perhaps also the *vulgare*-group crossed Macassar Strait in an eastern direction; it is not impossible, however, that the *vulgare*-group made use of the Philippine bridge at a later period.

Though the original centre of speciation in E. Malaysia may have been in Celebes and the Moluccas — where the *oleosum, hirsutum,* and *asperum*-groups seem to have originated — in more recent times the main centre of speciation developed in New Guinea, and from there some groups spread into Polynesia as far as Samoa.

In the mean time sect. *Canarium* richly diversified in W. Malaysia; by some unknown cause it was either not very successfull in getting a foothold in continental Asia, or it may later on have become obsolete there. The *denticulatum*-group spread far to the west however, and even succeeded in reaching Africa via the islands south of the Asiatic continent and Madagascar.

In more recent times, finally, the contact between E. and W. Malaysia remained apparently possible by the Philippine bridge; this track was mainly used by the *hirsutum*- and *asperum*-groups in a western and possibly by the *vulgare*-group in an eastern direction. Especially the western expansion of the *asperum*-group may have taken place in rather recent time, as it reached only as far as Borneo, and did not give rise to new species in W. Malaysia.

The picture given above is only partly in accordance with Lam's vision as to the phylogeny of the *Burseraceae* (1932b, 298—306). Being not familiar with the non-Malaysian representatives he regarded Africa as a possible centre of origin of *Canarium,* from where it might have reached Malaysia. This, however, seems improbable, both on account of the many highly advanced characters of the African *C. schweinfurthii* and of the relationships within the genus as stated above.

Conspectus specierum

A. Sect. Canarium

a. littorale-group

1. *C. littorale*
2. *C. latistipulatum*
3. *C. perlisanum*
4. *C. patentinervium*
5. *C. caudatum*
6. *C. divergens*
7. *C. kinabaluense*

b. maluense-group

8. *C. maluense*
9. *C. megacarpum*
10. *C. lamii*
11. *C. sylvestre*
12. *C. piloso-sylvestre*
13. *C. salomonense*
14. *C. harveyi*

c. vulgare-group

15. *C. vulgare*
16. *C. indicum*
17. *C. kaniense*
18. *C. luzonicum*
19. *C. ovatum*

d. denticulatum-group

20. *C. odontophyllum*
21. *C. denticulatum*
22. *C. karoense*
23. *C. megalanthum*
24. *C. manii*
25. *C. zeylanicum*
26. *C. paniculatum*
27. *C. madagascariense*
28. *C. schweinfurthii*

e. apertum-group

29. *C. pseudopatentinervium*
30. *C. grandifolium*
31. *C. apertum*

Incertae sedis

f. decumanum-group

32. *C. pseudodecumanum*
33. *C. decumanum*

B. Sect. Pimela

g. oleosum-group

34. *C. oleosum*
35. *C. balsamiferum*
36. *C. trigonum*
37. *C.* [illegible]
38. *C.* [illegible]

h. pilosum-group

39. *C. kostermansii*
40. *C. pilosum*
41. *C. merrillii*
42. *C. album*
43. *C. pimela*
44. *C. parvum*
45. *C. subulatum*
46. *C. bengalense*
47. *C. strictum*
48. *C. capitatum*
49. *C. intermedium*
50. *C. kipella*
51. *C. australianum*

i. dichotomum-group

52. *C. dichotomum*
53. *C. fusco-calycinum*

j. hirsutum-group

54. *C. hirsutum*
55. *C. pseudosumatranum*
56. *C. sumatranum*
57. *C. rigidum*
58. *C. polyphyllum*
59. *C. cestracion*

k. asperum-group

60. *C. vrieseanum*
61. *C. asperum*
62. *C. schlechteri*
63. *C. acutifolium*
64. *C. macadamii*
65. *C. chinare*
66. *C. vanikoroense*
67. *C. smithii*
68. *C. vitiense*
69. *C. samoense*

C. Sect. Canariellum

70. *C. baileyanum*
71. *C. muelleri*
72. *C. oleiferum*
73. *C. trifoliolatum*
74. *C. balansae*
75. *C. whitei*

SPECIAL PART

CANARIUM

Stickman, 1754, 10 (*sphalm. Cenarium*). — *Nanari* Adanson, 1763, 342, *nom. superfl.* — *Pimela* Loureiro, 1790, 407. — *Colophonia* Commerson *ex* Kunth, 1824, 352. — *Canariopsis* Blume *ex* Miquel, 1859, 651. — *Sonzaya* Marchand, 1867, 64. — *Lipara* Loureiro *ex* Gomes, 1868, 30, *nom. nud.* — *Canariellum* Engler, 1896, 242.

Type species: *C. indicum* L.

Trees, often buttressed, occasionally shrubs or (pseudo-)lianas. Bark usually smooth, somewhat scaly, greyish. *Twigs* terete or rarely angular; pith nearly always with vascular strands, the phloem of which mainly consists of some or only one resin-canal(s). *Leaves* spirally arranged or very rarely whorled in threes, usually more or less fascicled at the ends of the twigs; imparipinnate, very rarely unifoliolate. *Stipules* often present, inserted either on the twig next to the base of the petiole, or partly or entirely on the latter; rather different in shape and size, not rarely very caducous and visible in the terminal bud only. *Petioles* terete or flattened to channelled, especially near the base; swollen at the base, as are the nodes of the rhachis and both ends of the petiolules; pith always with vascular strands. *Rhachis* usually keeled above. *Petiolules* terete. *Leaflets* nearly to strictly opposite, base of laterals slightly oblique, margin entire to dentate or serrate, apex almost always distinctly acuminate, the nerves mostly more or less distinctly interarching near the margin, the veins mainly transverse; basal pair of leaflets usually smaller than the others. *Inflorescences* axillary (together sometimes pseudoterminal) or terminal, thyrsoid (sometimes reduced to racemes or spikes, especially the ♀ ones, which are always smaller), bracteate. *Flowers* 3-merous, unisexual, dioecious. *Receptacle* flat or (in ♀ flowers of many species) concave. *Calyx* cupular, sepals usually about halfway connate, the lobes deltoid; outside hairy or glabrous, inside nearly always densely sericeous. *Petals* 3, free, in bud usually imbricate, induplicate-valvate near the apex; nearly always oblong-obovoid, very rarely unguiculate, usually slightly conduplicate; entire, the apex usually with a small inflexed apiculum; fleshy and often rather thick with the exception of the margins; outside usually more or less hairy except the base and margins, inside very rarely hairy; creamy white. *Stamens* 6, in one whorl, epipetalous ones sometimes more or less to totally abortive; free to entirely connate, sometimes adnate to the disk; in ♀ flowers sterile and often less well developed; the filaments flattened (rarely filiform), tapering towards the apex; anthers dorsifix, attached slightly above their base, usually oblong to lanceolate, the thecae opening latero-introrse with a longitudinal slit, connective not strongly developed. *Disk* intrastaminal, 6-lobed, in ♂ flowers usually strongly developed, sometimes adnate either to the stamens or to the pistillode, in ♀ flowers often adnate to the stamens and, if the receptacle is concave, nearly entirely adnate to the latter. *Pistillode* in ♂ flowers usually much reduced to absent, sometimes united with the disk to an 'ovariodisk', which even can bear a 'style'; pistil sometimes fully replaced by the strongly developed and massive disk. *Pistil* in ♀ flowers consisting of an ovoid to ellipsoid ovary, tapering into a cylindrical style, with a small, capitate, faintly 3-lobed stigma; when the receptacle is concave the pistil is usually shortly stalked, the stalk, however, represents no true gynophore, as it consists of the fertile part of the ovary; ovary 3-celled, with 2 collateral epitropous ovules per cell. *Infructescences* like the ♀ inflorescences, with thickened branches and enlarged calyces. *Fruits* usually plum-shaped, drupaceous, blue-black when ripe (rarely ivory-white or red), hairy, especially near base and apex, or glabrous; pericarp fleshy (rarely fibrous); pyrene stony, consisting of the mesocarp, the endocarp, and an axial intrusion; cells 3, 1 or 2 of which may be sterile and slightly to almost completely reduced (usually with the exception of the endocarp-layer, however). *Seeds* 1 per cell, testa brown; exalbuminous, oily, cotyledons palmatifid to 3-foliolate, contortuplicate or folded.

Distribution: Tropical W. and E. Africa, Madagascar, Mauritius, Ceylon, S.E. Asia (from S. Deccan to S. China and Hainan), Malaysia, N.E. Australia, and Melanesia as far east as Samoa.

Ecology: Mainly canopy elements of primary and secondary rain forests at low to medium altitudes; sometimes in monsoon forests or parklands, in Australia also on coastal dunes. Fl. mainly in the dry season, fr. in the rainy season; many species, however, have apparently no special flowering and fruiting seasons. The pollination is very probably effectuated by insects, the seed dispersal by birds (fruit pigeons) and mammals (monkeys).

Uses: The timber of almost all species is soft to moderately hard, moreover it is cross-grained; it plays no part of any importance in the world trade.

The resin, which is often abundant, is of more importance. Especially the *manila-elemi* (*C. luzonicum*) is used in pharmacy in ointments and plasters; moreover, it is a constituent of cellulose lacquers. (For further details see: Tschirch und Stock, Die Harze 2, 1935, 273—327). It is to be expected that the resins of many other species are also economically valuable, but very little is known of this matter.

The seeds of several species are estimated, though only in the Solomons they are (or were?) an important constituent of the diet; in Malaysia and China they are a valued titbit (in China the fleshy pericarp is also eaten). The oil pressed out the seeds is locally used.

KEY I. **Introductory key**

1.a. Stipules present (often rather caducous, traceable by their scars; in some species present only in the terminal bud and scars nearly invisible) 2
b. Stipules absent . . . . **Key V**
2.a. Either stipules flattened, scars elliptic to linear, or stipules auricle-shaped, scars drop-shaped; sometimes stipules represented by a basal pair of small, caducous,

normal leaflets, scars minute, circular . . . . . . sect. **Canarium, Key II**
b. Stipules subulate to narrowly triangular, scars minute, circular
sect. **Pimela, Key III**

KEY II. Sect. CANARIUM

1.a. Stipules (or their scars) present 5
b. Stipules absent 2
2.a. Terminal bud 3—5 cm long. *W. Malaysia* . . . . **32. C. pseudodecumanum**
b. Terminal bud up to 1½ cm long 3
3.a. Leaves 1—2(—4)-jugate, usually glabrous; leaflets entire; apex shortly blunt-acuminate; leaflets greenish when dry. *W. Malaysia*
29. C. pseudopatentinervium
b. Leaves (2—)3—7-jugate, very rarely glabrous; leaflets usually minutely fimbriate-serrate; apex blunt or acutely acuminate; leaflets brownish when dry 4
4.a. Leaflets elliptic, base cuneate; leaves 2—3-jugate. *Malay Peninsula*
30. C. grandifolium
b. Leaflets more or less irregularly shaped, either greatest width near the base or margins parallel; base rounded or truncate to subcordate; leaves (2—)3—7-jugate. *W. Malaysia* . . . . **31. C. apertum**
5.a. Stipules represented by a pair of normal small leaflets, which are inserted at the base of the petiole; scars small, circular. *Borneo, E. Malaysia*
33. C. decumanum
b. Stipules and their scars not as above 6
6.a. Stipules inserted at the base of the petiole, partly or entirely on the branchlet 7
b. Stipules distinctly fully on the petiole (if dubious see under a) 18
7.a. Stipules entire, often very caducous 8
b. Stipules not entire, usually rather persistent 15
8.a. Stipules moderately caducous, oblong, 1—5 by ½—1¾ cm; scars linear, c. ½ cm long. *E. Malaysia, Kangean & Bawean* . . . . **15. C. vulgare**
b. Stipules very caducous, reniformous to roundish, much smaller; scars elliptic, 1—2 mm long 9
9.a. Fruits 8 by 5 cm; pericarp fibrous; stone acutely triangular with concave sides. *New Guinea* . . . . **9. C. megacarpum**
b. Fruits smaller; pericarp fleshy; stone not as above 10
10.a. Inflorescences axillary, together pseudo-terminal (vegetative terminal bud present). *Philippines* . . . . **18. C. luzonicum**
b. Inflorescences terminal 11
11.a. Stamens in ♂ flowers 3. Leaflets caudate-acuminate, tapering at base and apex. *W. Malaysia* . . . . **5. C. caudatum**
b. Stamens 6. Leaflets usually otherwise 12
12.a. Nerves few (5—15 pairs), mutual distance along the midrib large (1—1½ cm); veins inconspicuous. Leaflets glabrous, entire 13
b. Nerves rather many (9—22 pairs), dense (distance along midrib usually ½—1 cm); venation more or less conspicuous to prominent. Leaflets not rarely pubescent, mostly entire 14
13.a. ♂ Inflorescences very lax, branches long and transverse. ♂ Flowers 13 mm long. *Borneo* . . . . **6. C. divergens**
b. ♂ Inflorescences not very lax. ♂ Flowers *c.* 8 mm long. *W. Malaysia*
4. C. patentinervium
14.a. Nervation very regular, nerves dense, nearly straight and parallel (angle 75—85°), abruptly and distinctly interarching. Leaflets regular, elliptic to elliptic-ovate; base equilateral, rather broad; apex abruptly, shortly, broadly, and bluntly acuminate. Disk in ♂ flowers very rarely with a 'style'. *E. Malaysia, Borneo*
8. C. maluense
b. Leaflets and nervation not conspicuously regular. Ovariodisk in ♂ flowers nearly always with a 'style'. *W. Malaysia, Indo-China* . . . . **1. C. littorale**
15.a. Inflorescences terminal (vegetative terminal bud absent) 16
b. Inflorescences axillary, sometimes together pseudoterminal (vegetative terminal bud present) 17

16.a. Fruit-stone 2—3 cm diam., rounded triangular in cross-section, the sides usually convex. Stipules dentate. *E. Malaysia to New Hebrides* . . . **16. C. indicum**
b. Fruit-stone 3—4 cm diam., acutely deltoid in cross-section, sometimes even winged, sides usually concave. Stipules deeply repeatedly dentate to fimbriate. *New Guinea* . . . . **17. C. kaniense**
17.a. Leaflets dentate to serrate, pilose. *Sumatra, Borneo, Palawan* **20. C. odontophyllum**
b. Leaflets entire, glabrous *Sumatra* . . . . **22. C. karoense**
18.a. Stipules deeply incised, pectinate to dendriform 19
b. Stipules entire 20
19.a. Flowers ♂ 4—5 mm long, ♀ 7—8 mm. Fruits up to 3 by 1½ cm. *Philippines, W. Malaysia, Andamans, Burma* . . . . **21. C. denticulatum**
b. Flowers ♂ 11 mm long, ♀ 13—15 mm. Fruits 5—5½ by 3½—4 cm. *W. Malaysia* **23. C. megalanthum**
20.a. Inflorescences axillary, sometimes together pseudo terminal (vegetative terminal bud present) 21
b. Inflorescences terminal (vegetative terminal bud absent) 25
21.a. Stipules oblong-spathulate, *c.* 3½ by ½ cm, together with the broadened basal part of the petiole enclosing the terminal bud. ♂ Flowers with androphore. *W. and Central Africa* . . . . **28. C. schweinfurthii**
b. Stipules rotundate or linguiform, much smaller. No androphore 22
22.a. Leaflets crenulate, at least in the apical part. *Malay Peninsula* **3. C. perlisanum**
b. Leaflets entire 23
23.a. Stipules linguiform, stiff, coriaceous, persistent. *Philippines* . . **19. C. ovatum**
b. Stipules roundish or auricle-shaped, herbaceous, often rather caducous . . 24
24.a. Nerves usually up to 13 pairs. Pistil glabrous. Dried leaflets greenish-brown, the nerves straw-coloured. Fruit-stone nearly always distinctly ribbed. *Solomon Islands to Samoa and Tonga* . . . . **14. C. harveyi**
b. Nerves 14—18 pairs. Pistil pilose. Dried leaflets dull yellowish- to red-brown, nerves not light-coloured. Fruit-stone smooth. *Philippines* . **18. C. luzonicum**
25.a. Leaflets dentate or serrate, at least in the apical part 26
b. Leaflets entire (rarely slightly undulate) 27
26.a. Leaflets chartaceous, distinctly, though sparsely, pubescent on midrib and nerves beneath; margin entirely minutely serrate. Stipules chartaceous. *Borneo* **2. C. latistipulatum**
b. Leaflets coriaceous, glabrous, or with a few hairs on the midrib beneath only; margin dentate towards the apex. Stipules coriaceous. *Borneo* **7. C. kinabaluense**
27.a. Ovariodisk in ♂ flowers with 'style'. Leaflets caudate-acuminate, tapering at both ends. *W. Malaysia* . . . . **5. C. caudatum**
b. Disk in ♂ flowers without 'style'. Leaflets mostly otherwise 28
28.a. Fertile fruit-cells bean-shaped in cross-section thanks to a strong parietal rib 29
b. Fruit-cells without a strong parietal rib 31
29.a. Fruits nearly always pustular-scabrous. Leaves 2—9-jugate, glabrous or pilose. Pistil usually pilose. *Madagascar, E. Africa* . . . **27. C. madagascariense**
b. Fruits smooth to slightly papillose. Leaves up to 4-jugate, glabrous. Pistil glabrous 30
30.a. Fruits 2½—3 by 1½ cm. Nerves 9—12 pairs. *Andamans* . . . **24. C. manii**
b. Fruits 4½ by 2 cm. Nerves 12—18 pairs. *Ceylon* . . . **25. C. zeylanicum**
31.a. Stipules 1¼—2 by 1 cm, rather persistent. Fruits 6 by 4 cm. *New Guinea* **10. C. lamii**
b. Stipules (usually much) less than 1 by 1 cm. Fruits up to 5½ by 2¾ cm . 32
32.a. Nerves 15—23 pairs. *E. Malaysia* . . . . **8. C. maluense**
b. Nerves 8—15 pairs 33
33.a. Twigs, leaves, and inflorescences pilose. *New Guinea* **12. C. piloso-sylvestre**
b. Plant glabrous 34
34.a. Leaflets tapering at both ends, base acute, acumen long and slender. Stamens 6—3. *E. Malaysia* . . . . **11. C. sylvestre**
b. Leaflets not tapering at both ends, base broadly cuneate, truncate or cordate, acumen short and broad. Stamens 6 35
35.a. Pith of the branchlets with a number of small vascular strands, part of which

are peripherally arranged. Fruits flattened-ellipsoid; stone smooth with the exception of 3 blunt white ribs at the base. *New Guinea, Solomon Islands* **13. C. salomonense**

b. Pith of the branchlets without, or with a few peripheral, vascular strands. Fruits long-ovoid; stone faintly rugged. *Mauritius* . . . **26. C. paniculatum**

KEY III. Sect. PIMELA

1.a. Terminal bud *c.* 3 cm long, slender, curved, ferruginous-tomentose. *Sumatra, Malay Peninsula* . . . . **56. C. sumatranum**

b. Terminal bud up to 1 cm long 2

2.a. Stipules (or their scars) present, at least in the terminal bud 3

b. Stipules absent 24

3.a. Stamens free (see also *C. vrieseanum,* in which the stamens are free in ♀ flowers, connate in ♂ ones) 4

b. Stamens more or less connate (unknown in *C. cestracion* and *chinare*) . . . 8

4.a. Stamens pilose. *Malaysia, Carolines, Solomon Islands* . . . **54. C. hirsutum**

b. Stamens glabrous 5

5.a. Disk pilose 6

b. Disk glabrous 7

6.a. Inflorescences up to 50 cm long, with many flowers. Flowers *c.* 4 mm. Calyx in fruit flat, the lobes reflexed. Fruits ovoid to globular. *E. Malaysia* **63. C. acutifolium**

b. Inflorescences up to 12 cm long, with up to *c.* 10 flowers. Flowers 7—13 mm. Calyx in fruit funnel-shaped. Fruits spindle-shaped. *Fiji* . . . **68. C. vitiense**

7.a. Fruits 9—14 by 4—11 mm; stone (nearly) smooth. Inflorescences usually spicate or compoundly spicate. *Philippines, E. Malaysia, Bawean & Kangean, Solomon Islands* . . . . **61. C. asperum**

b. Fruits 25 by 13—15 mm; stone very rugged. Inflorescences thyrsoid. *Samoa* **69. C. samoense**

8.a. All vascular strands in the pith of the branchlets scattered. Fruits very characteristic (see description). *New Guinea* . . . . **59. C. cestracion**

b. All or part of the vascular strands in the pith of the branchlets arranged into a peripheral cylinder. Fruits not as above 9

9.a. Leaflets distinctly densely papillose beneath, rough on the touch (sometimes every papilla bearing a hair). Stamens less than halfway up connate; pistil glabrous. Mature fruits bluish-black. *Borneo* . . . . . . **41. C. merrillii**

b. Leaflets not papillose beneath (in *C. album* sometimes papillose, then stamens connate halfway up or more, pistil pilose, mature fruits white) 10

10.a. Inflorescences and infructescences terminal, pyramidal, laxly dichotomously branched, up to 40 cm long **11**

b. Inflorescences and infructescences axillary (in *C. pilosum* sometimes terminal, then rather narrowly thyrsoid and up to 25 cm long) 12

11.a. Leaves 3- or more-jugate, subglabrous as are the branchlets. *Sumatra, Borneo* **52. C. dichotomum**

b. Leaves 1—2(—3)-jugate, thinly and shortly pubescent as are the branchlets. *Borneo* **53. C. fusco-calycinum**

12.a. Nerves 22—25 pairs. Pith of the branchlets with 2 concentric cylinders of vascular strands. Mature leaflets glabrous. *Borneo* . . . **39. C. kostermansii**

b. Nerves usually up to 20 pairs (if more, then central vascular strands in pith of branchlets not cylindrically arranged, and mature leaflets usually not glabrous) 13

13.a. Leaves (6—)9—10-jugate, (sub-)glabrous. All vascular strands in pith of branchlets peripherally arranged. Stamens in both ♂ and ♀ flowers connate for more than half the length of the filaments. Fruits acutely triangular in cross section. *Continental SE. Asia* . . . . **46. C. bengalense**

b. Leaves up to 6-jugate (in some species exceptionally up to 7-jugate, mainly on suckers; then differing in most of the other characters mentioned above) 14

14.a. Corolla 2—3 times as long as the calyx, flowers long and slender . . . 15

b. Corolla less than twice as long as the calyx (unknown in *C. chinare*) . . . 19

15.a. Tips of the branchlets, leaves, and inflorescences shaggy ferruginous-pilose, glabrescent. Fruits usually prismatic, slightly blunt-triangular in cross-section, truncate and with 3 distinct shoulders at the apex. *W. Malaysia* **40. C. pilosum**

b. Pubescence variable, usually tomentose, never shaggy. Fruits not as above . 16

16.a. Margin of the leaflets minutely serrate, dentate, or repandous. *Thailand, Indo-China* . . . . . . **45. C. subulatum**

b. Leaflets entire 17

17.a. Stamens connate for half the length of the filaments or more Fruits white. *Indo-China, S. China, Hainan* . . . . . . **42. C. album**

b. Filaments distinctly less than halfway connate. Fruits bluish-black . . . 18

18.a. Stipules usually inserted on the petiole at 1—3 cm from its base. Disk in ♂ flowers more or less cylindrical, 3 mm high; stamens up to 3 mm connate. Fruits *c.* 4 by 2 cm. *New Guinea, New Britain* . . . . **62. C. schlechteri**

b. Stipules usually inserted next to or on the base of the petiole. Disk in ♂ flowers cupular, ½ mm high; stamens slightly confluent at the base only. Fruits 1½—2¼ by 1½—1¾ cm. *Fiji* . . . . . . **67. C. smithii**

19.a. Fruits remaining velvety pubescent for a long time. Stipules inserted on the petiole up to 1½ cm from its base, narrowly triangular, falcate (in *C. australianum* the stipules are also sometimes inserted on the petiole; for differences see there). *Philippines, Celebes* . . . . . . **60. C. vrieseanum**

b. Fruits glabrous. Stipules usually inserted at the base of the petiole . . . 20

20.a. Young parts, lower side of leaflets, and inflorescences remaining densely pubescent for rather a long time. Stipules subulate. Leaflets often not fully entire; base in the upper pair of leaflets often in the lower half decurrent till the rhachis; nerves 12—24 pairs 21

b. Glabrous with the exception of the tip of the twigs. Stipules mostly flattened. Leaflets entire; base never as above; nerves 8—16 pairs 22

21.a. Leaflets 10—20 by 4—10 cm, tapering acuminate at apex, darkbrown when dry, densely reddish-brown pubescent beneath; nervation regular. *Continental S. Asia* **47. C. strictum**

b. Leaflets 7—11(—17) by 3—7 cm, apex rounded to acute, sometimes abruptly, very shortly, blunt-acuminate; greyish-green when dry; glabrous or minutely greyish to yellowish tomentose beneath; nervation usually rather irregular (nerves dense, tortuous, and more or less fading towards the margin). *Australia, New Guinea* . . . . . . **51. C. australianum**

22.a. Base of lateral leaflets cuneate. Leaflets rather small and narrow (5—11 by 2—4½ cm). Fruits up to 2½ cm long. *New Guinea to Solomon Islands* **65. C. chinare**

b. Base of lateral leaflets truncate to rounded. Leaflets bigger and especially broader (8—18 by 3½—9 cm). Fruits 3½—4 cm long 23

23.a. Flowers glabrous. Calyx in fruit *c.* 5 mm diam. Pyrene of the fruits smooth. Pith of the branchlets with central vascular strands. *New Guinea* **64. C. macadamii**

b. Corolla outside pubescent. Calyx in fruits 12—15 mm diam. Pyrene of the fruits very rugose. Pith of the branchlets without vascular strands. *New Hebrides, Fiji* . . . . . . **66. C. vanikoroense**

24.a. Leaves, inflorescences, and infructescences manifestly lax (lateral petiolules 1—1½ cm, terminal ones 3—4 cm, petioles 10—14 cm, interjugal parts 4—8 cm). Disk in ♂ flowers pistilloid, stalked, globular, hollow. Fruits oblique, bulging on one side; central canal much widened. *Philippines* . . . . **38. C. gracile**

b. Leaves, inflorescences, and infructescences not very lax. ♂ Flowers and fruits not as above 25

25.a. Filaments of the stamens pilose 26

b. Filaments glabrous 27

26.a. Branchlets slender (leafy part 3—4 mm thick). *Celebes* . . **36. C. trigonum**

b. Branchlets thick (1½—3 cm in the leafy part). *Celebes, Moluccas* **54. C. hirsutum**

27.a. Petals strongly thickened in the apical part, the broadened and flattened margins rugose. Fruits 4—5 by 2—2½ cm, the stone very rugose 28

b. Petals not strongly thickened. Fruits usually smaller, the stone smooth or with 3—6 longitudinal ribs 29

28.a. Leaflets narrow (6¼—15 by 1¼—4 cm), glabrous. *New Guinea* **57. C. rigidum**

b. Leaflets broader (5½—20 by 2½—8 cm), pubescent on midrib and nerves. *New Guinea* . . . . 58. **C. polyphyllum**
29.a. Mature leaflets more or less pubescent 30
b. Mature leaflets glabrous 32
30.a. Pith of the branchlets without central vascular strands. *Indo-China* 44. **C. parvum**
b. Pith of the branchlets with central vascular strands 31
31.a. Leaflets entire. *Philippines* . . . . 37. **C. euryphyllum**
b. Leaflets undulate to dentate at the margin. *Continental S. Asia* 47. **C. strictum**
32.a. Fruits 5 by 2½ cm. Leaves 7—9-jugate. Leaflets stiff-chartaceous. Nerves 16—20 pairs. *Malay Peninsula* . . . . 55. **C. pseudosumatranum**
b. Fruits up to 4 cm long (if more than 4 cm, then leaves less jugate and nerves less numerous) 33
33.a. Disk in ♂ flowers pistilloid, with 'style'. Fruits small (up to 2 by 1¼ cm) (in *C. balsamiferum* the fruits are 2—4 by 1¼—2 cm; this species is different by the minutely tessellate reticulation of the leaflets). *E. Malaysia* 34. **C. oleosum**
b. Disk in ♂ flowers without 'style'. Fruits larger 34
34.a. Branchlets thick (*c.* 1½ cm in the leafy part), with very conspicuous, though not prominent, large (*c.* 1½ by 1½ cm) cordate laef-scars. Leaflets usually serrate to dentate. *Andaman and Nicobar Islands, Burma* . . 48. **C. euphyllum**
b. Branchlets usually much more slender, leaf-scars much smaller. Leaflets entire 35
35.a. Pistil pubescent. Stamens free or filaments less than halfway up connate. ♂ Flowers *c.* 1 cm long (in *C. pilosum* the stamens are in ♂ flowers confluent at the base only; these ♂ flowers are only ½ cm long, however) 36
b. Pistil glabrous. Filaments more than halfway up connate 37
36.a. Leaflets rather large (9—24 by 2—9¼ cm), short-acuminate; reticulations minutely tessellate. Fruits ± round in cross-section, bluish-black. *Celebes, Moluccas* 35. **C. balsamiferum**
b. Leaflets rather small (3½—12 by 2—4 cm), caudate-acuminate; reticulations not conspicuously dense. Fruits broad-triangular in cross-section, bright red when fresh. *Philippines* . . . . 37. **C. euryphyllum**
37.a. Pith of the branchlets usually without central vascular strands 38
b. Pith of the branchlets usually with central vascular strands 39
38.a. Leaves 0—5-jugate; leaflets regular-shaped. Stamens in ♂ flowers confluent at the base only. Corolla in ♀ flowerbuds slender. Fruits ellipsoid to fusiform, 1½ cm in diam. *Borneo* . . . . 40. **C. pilosum**
b. Leaves 4—6-jugate; leaflets oblique, more or less falcate. Stamens in ♂ flowers about halfway up connate. Corolla in ♀ flowerbuds conical. Fruits ovoid, 1¼—2 cm in diam. *Indo-China, S. China, Hainan* . . . . 43. **C. pimela**
39.a. Nerves 14—17 pairs. Filaments halfway connate; stamens in ♀ flowers as long as the pistil. *Sumatra* . . . . 49. **C. intermedium**
b. Nerves 10—12 pairs. Filaments nearly entirely connate, sometimes with interstaminal teeth; stamens in ♀ flowers about half as long as the pistil. *Java* 50. **C. kipella**

KEY IV. Sect. CANARIELLUM

1.a. Leaves 5—8-jugate. *New Caledonia* . . . . 75. **C. whitei**
b. Leaves unifoliolate to 3-jugate 2
2.a. Branchlets and at least lower side of the leaves ferruginously pilose. Leaves usually unifoliolate. *New Caledonia* . . . . 72. **C. oleiferum**
b. Plant early glabrescent. Leaves usually 1—3-jugate 3
3.a. Base of leaflets cuneate, apex rounded to shortly and broadly acuminate. Flowers *c.* 4 mm long 4
b. Base of leaflets rounded to cordate, apex shortly acuminate. Flowers *c.* 2 mm long 5
4.a. Leaves usually 1-jugate; petioles terete. *NE. Australia* . . 70. **C. baileyanum**
b. Leaves usually 3-jugate; petioles flattened above. *NE. Australia* 71. **C. muelleri**
5.a. Leaves spirally arranged, 1—2-jugate. *New Caledonia* . 73. **C. trifoliolatum**
b. Leaves whorled, 2—3-jugate. *Loyalty Islands* . . . . . 74. **C. balansae**

KEY V. **Species without stipules**

1.a. Pith of the branchlets without vascular strands . . . . Key IV

b. Pith of the branchlets with vascular strands 2

2.a. Terminal bud 3—5 cm long 3

b. Terminal bud up to 1½ cm long 4

3.a. More or less densely pubescent. Leaves 3—6-jugate; leaflets subsessile, 2(—3) times as long as wide. Inflorescences narrowly thyrsoid. Petals only slightly thickened in the apical part. Stamens free. Fruits 7 by 4½ cm or more. *W. Malaysia* . . . . **32. C. pseudodecumanum**

b. Practically glabrous. Leaves 7—11-jugate; leaflets often distinctly stalked, 2½—4 times as long as wide. Inflorescences broadly thyrsoid. Apical part of the petals strongly thickened, with rugose lateral surface. Stamens connate. Fruits 1½ by 1 cm. *Sumatra, Malay Peninsula* . . . . . **56. C. sumatranum**

4.a. Central part of the pith in the branchlets without vascular strands . . . 5

b. Central part of the pith in the branchlets with vascular strands 15

5.a. Inflorescences terminal. Petals unguiculate (in *C. pilosum* the inflorescences are very exceptionally also terminal, the petals are not unguiculate, however) key II no. 3

b. Inflorescences axillary. Petals not unguiculate 6

6.a. Leaflets more or less pubescent 7

b. Leaflets glabrous 8

7.a. Petals not strongly thickened in the apical part. Leaves 2—4-jugate. Nerves 10—12 pairs. *Indo-China* . . . . **44. C. parvum**

b. Petals strongly thickened in the apical part. Leaves 3—11-jugate. Nerves 11—24 pairs. *New Guinea* . . . . **58. C. polyphyllum**

8.a. Leaves whorled. *Loyalty Islands* . . . . **74. C. balansae**

b. Leaves spirally arranged 9

9.a. Leaf-scars on the branchlets very conspicuous (though not prominent), cordate, 1½ by 1½ cm. Leaflets mostly serrate or dentate. *Andaman and Nicobar Islands, Burma* . . . . **48. C. euphyllum**

b. Leaf-scars not very conspicuous. Leaflets entire 10

10.a. Nerves up to 15 pairs 11

b. Nerves 15—30 pairs 13

11.a. Stamens pilose. *Celebes* . . . . **36. C. trigonum**

b. Stamens glabrous 12

12.a. Disk in ♂ flowers with a 'style'. Stamens in ♀ flowers free. Fruits ovoid to obovoid, 1¼—2 by ¾—1¼ cm. *E. Malaysia* . . . . **34. C. oleosum**

b. Disk in ♂ flowers without 'style'. Stamens in ♀ flowers distinctly connate. Fruits 2—4 by 1—2 cm . . . . key III no. 38

13.a. Stamens pilose, free. Nerves 20—30 pairs. *Moluccas* . . . **54. C. hirsutum**

b. Stamens glabrous, connate. Nerves 15—20 pairs 14

14.a. Nerves not distinctly interarching. *Malay Peninsula* **55. C. pseudosumatranum**

b. Nerves distinctly interarching. *New Guinea* . . . . **57. C. rigidum**

15.a. Leaflets not fully entire. *Continental S. Asia* . . . . . . **47. C. strictum**

b. Leaflets entire 16

16.a. Leaves, inflorescences, and infructescences manifestly lax (lateral petiolules 1—1½ cm, terminal ones 3—4 cm, petioles 10—14 cm, interjugal parts 4—8 cm). Disk in ♂ flowers pistilloid, stalked, globular, hollow. Fruits oblique, bulging on one side; central canal much widened. *Philippines* . . . . **38. C. gracile**

b. Leaves, inflorescences, and infructescences not very lax. ♂ Flowers and fruits not as above 17

17.a. Stamens pilose. Fruits prickly-hairy. *Celebes* . . . . . . **54. C. hirsutum**

b. Stamens and fruits glabrous 18

18.a. Vascular strands in the pith of the branchlets without resiniferous parts. Fruits 2-merous. *New Caledonia* . . . . **75. C. whitei**

b. Vascular strands in the pith of the branchlets with resiniferous ducts. Fruits essentially 3-merous . . . . key III no. 35

I. SECTION CANARIUM

Sect. *Canaria* DC. Prod. 2 (1825) 79. — Sect. *Progressiva* and sect. *Regressiva* subsect. *Auriculata* H. J. Lam, Ann. Jard. Bot. Btzg 42 (1932) 214 and 209.

Stipules either foliaceous or pectinate, enveloping the terminal bud, or small and shrivelled, auricle-shaped, rarely absent; scars mostly linear or, if on the petiole, drop-shaped. *Bracts* usually consisting of the persistent connate stipules, concave, enveloping the flower buds, rarely lanceolate to subulate. *Leaflets* brownish when dry; margin entire to dentate; indument, if present, shortly tomentose. *Inflorescences* usually terminal, rarely all axillary. *Stamens* usually free or adnate to the disk, very rarely up to halfway connate. ♀ *Flowers* nearly always with a concave receptacle; in that case disk adnate to the receptacle and pistil stalked; *disk* and *pistil* usually glabrous. *Calyx* in fruit rarely less than 1 cm diam., usually flat with undulate margin, or more or less funnel-shaped, often densely tomentose. *Fruits* rather large, usually 5—7 cm long; pyrene smooth, sometimes with angle- and median ribs.

Distribution: Africa, Madagascar, Mascarenes, Ceylon, Burma, Andamans, Indo-China, Malaysia, Solomon Isl., New Hebrides, Fiji, Samoa, and Tonga.

1. **Canarium littorale** Blume, 1826, 1164; Roemer & Schultes, 1830, 1625; Blume, 1850, 218; Miquel, 1859, 645; Engler, 1883, 126; Koorders & Valeton, 1896, 36; Backer, 1911, 198; Koorders, 1912, 433; Heyne, 1927, 877; Lam, 1932a, t. 13 f. 104g, t. 15 f. 119b; 1932b, 498, t. 13 f. 82; Corner, 1940, t. 39, *sub C. sp.*; Lam, 1948, 5; Wyatt-Smith, 1953, 11, *cum fig.*; Leenhouts, 1956, 256; *non* Ridley, 1922, 375 (= *C. patentinervium* Miq.). — *C. glaucum* Blume, 1850, 219; Miquel, 1859, 645; Engler, 1883, 140; King, 1894b, 249; Merrill, 1921, 317; *non* Hochreutiner, 1905, 69 (= *Protium serratum* Engl.). — *C. tomentosum* Blume, 1850, 219; Miquel, 1859, 644; Engler, 1883, 120; Lam, 1932a, 214, t. 12 f. 93, t. 15 f. 119d, e, *incl. var. typicum et var. flavum*; 1932b, 496, t. 12 f. 81; Wyatt-Smith, 1953, 10, *cum fig.* — *C. serricuspe* Miquel, 1859, 649; Engler, 1883, 148; Heyne, 1927, 878. — *C. serrulatum* Miquel, 1859, 646; 1869, 116. — *C. purpurascens* Bennett, 1875a, 532; 1875b, 103; Engler, 1883, 115; King, 1894b, 245; Ridley, 1900a, 58; 1922, 370; Burkill, 1935, 432; *non* Henderson, 1939, 39 (= *C. perlisanum* Leenh.). — *C. rufum* Bennett, 1875a, 533; 1875b, 103; Engler, 1883, 107; King, 1894b, 244; Ridley, 1900a, 58; Guillaumin, 1909a, f. 17, 22^{14}, 23^{4}; Ridley, 1922, 372; Buckley, 1932, 34; Lam, 1932a, t. 11 f. 79, t. 13 f. 104 1; 1932b, 494, t. 12 f. 80; Burkill, 1935, 432; Wyatt-Smith, 1953, 9, *cum fig.* — *C. secundum* Bennett, 1875a, 532; 1875b, 103; Engler, 1883, 116; King, 1894b, 250; Ridley, 1900a, 58; Hochreutiner, 1904, 62; Guillaumin, 1909a, f. 9; Ridley, 1922, 375; Burkill, 1935, 432. — *C. acutum* Engler, 1883, 113. — *C. bennettii* Engler, 1883, 119. — *C. giganteum* Engler, 1883, 106. — *C. pruinosum* Engler, 1883, 106; Lam, 1932a, t. 11 f. 69; 1932b, 492, t. 12 f. 79. — *C. pseudocommune* Hochreutiner, 1904, 60, *incl.* also *var. subelongatum*; Guillaumin, 1909a,

f. 22^{2}; Hochreutiner, 1910, 842, *incl.* also *var. genuinum.* — *C. subtruncatum* (*non* Engl.) Baker, 1924, 16. — *C. flavum* Ridley, 1930, 81.

Type: Java, Nusa Kembangan, Nov., *Blume 1736,* ♂ (L; isotypes in L, MEL, U).

Tree (3—)10—30(—44) m by 20—70(—100) cm, sometimes buttressed. *Branchlets* ¼—1 cm thick, glabrescent; pith with some large to many small vascular strands, all or part of them peripherally arranged. *Stipules* caducous, inserted on the branchlet near the base of the petiole, reniformous, 5 by 4 mm, with various intergrades to: subpersistent and inserted on the base of the petiole, semi-rotundate, 17 by 12 mm, margin repandous; nearly always tomentose. *Leaves* (0—)2—6-jugate, 17—60 cm long, glabrous to tomentose. *Leaflets* ovate to oblong-lanceolate, 3—27 by 1—9 cm, chartaceous to coriaceous, smooth to bullate, glabrous — sometimes waxy white beneath — to densely tomentose beneath and on the midrib above; base cuneate to faintly cordate, slightly inequilateral; margin entire to dentate or serrulate; apex (gradually to) rather abruptly shortly acute-acuminate, acumen mostly dentate or serrate; nerves 9—22(—29) pairs (angle 60—90°, gradually decreasing from base to apex), slightly curved, often partly arching near the margin. *Inflorescences* terminal, sometimes with additional ones in the upper leaf-axils, thyrsoid (♂) to subracemose (♀), 5—40 cm long, often densely reddish-brown tomentose, sometimes glabrous. *Bracts* concave. *Flowers* 8—13 mm long, outside densely ferruginously pubescent. *Calyx* 4—9 mm high. *Stamens* 6, filaments glabrous, in ♂ flowers often slightly connate, adnate to the disk, in ♀ flowers inserted on the rim of disk. *Disk* in ♂ flowers from globular, solid, tapering into a style-like appendix, to: cupular, thick-fleshy, without any rudiment of the pistil; 1—3 mm high, nearly always glabrous; in ♀ flowers minute, faintly 6-undulate, glabrous to tomentose. *Pistil* glabrous or pilose. *Infructescences* 5—25 cm long, densely tomentose, with 1—6 fruits; calyx funnel-shaped, triangular, *c.* 8 mm diam., to: flat, orbicular, 1½ cm diam., with undulate margin. *Fruits* ellipsoid (to obovoid), rounded triangular in cross-section, 4½—7 by 1½—3 cm, sparsely pilose to glabrous; pyrene smooth, acutely triangular in cross-section; lids 2—4 mm thick. *Seeds* 1—2, sterile cells moderately reduced.

Distribution: Indo-China, Sumatra, Malay Peninsula, Java, Borneo.

Taxonomy. This species is very variable, both in its vegetative parts and, to a lesser degree, in its flowers. Though nearly all of these variations are connected by intergrades with a central form, they are more or less geographically defined. For that reason and as the extreme specimens are very characteristic, I propose a subdivision of the species into 5 forms.

KEY TO THE FORMS

1.a. Lower side of the leaflets more or less glaucous- to white-waxy, glabrous except midrib and nerves 2
b. Lower side of the leaflets not waxy, usually distinctly pubescent . . . 3
2.a. Leaflets entirely densely dentate, distinctly white waxy beneath; midrib, nerves, and veins prominent beneath. *Borneo* . . . . f. **pruinosum**
b. Leaflets scattered dentate, mainly towards the apex; more or less distinctly glaucous waxy beneath; midrib and nerves prominent beneath, veins inconspicuous. *Sumatra, Malay Peninsula, Annam* . . . . f. **purpurascens**

3.a. At least veins and veinlets not very prominent beneath; pubescence on the lower side of the leaflets not minutely tomentose. *Sumatra, Java* f. **littorale**

b. Nervation and venation strongly prominent beneath, wafflelike; lower side of the leaflets densely minutely tomentose 4

4.a. Leaflets entire to scattered dentate to the apex. More slender form. *Borneo* f. **tomentosum**

b. Leaflets entirely densely dentate. More coarse form. *Malay Peninsula* f. **rufum**

a. forma **littorale.**

Branchlets slender. Stipules small, reniformous, inserted on the branchlet. Leaves 2—3-jugate. Leaflets ovate to lanceolate, c. 12—17 by 5—7 cm, chartaceous, nearly glabrous, not waxy beneath; base rounded to broadly cuneate; margin entire to scattered dentate near the apex; nerves 11—15 pairs. Flowers small; disk in ♂ ones with style-like appendix.

Specimens which exactly agree with the type are only known from Java; they are slightly deviating from the bulk, which is abundant on Sumatra, the Malay Peninsula, and Java.

b. forma **purpurascens** (Benn.) Leenh., *nov. stat.* — *C. purpurascens* Benn.

Type: Malacca, *Griffith Kew distr. 1142,* ♂ (K; isotypes in CAL, FI, G, L, P, W).

This form mainly differs from the foregoing one by its stouter habit, its slightly larger stipules, which are partly inserted on the base of the petiole, its 3—4-jugate leaves, and by its leaflets, which are slightly glaucous waxy beneath. It is known from Sumatra and the Malay Peninsula, furthermore from Indo-China.

This form is closely related to the foregoing one; especially in Sumatra they are transgrading into each other, the most extreme specimens are collected in Indo-China.

c. forma **pruinosum** (Engl.) Leenh., 1956, 258. — *C. pruinosum* Engl.

Type: Borneo, Sarawak, *Beccari PB 1970,* ♀ (K; isotypes in FI, K).

Leaflets waxy white beneath; margin closely dentate.

A local form, known only from Sarawak and North Borneo. It is the only one which is not connected by intergrades with other forms; though its characters are of minor importance its habit is very conspicuous.

d. forma **tomentosum** (Bl.) Leenh., *nov. stat.* — *C. tomentosum* Bl.

Type: (SE. Borneo ?, *Korthals ? in*) *herb. L. 898.319—381,* fr. (L; isotype in U).

Stipules caducous, inserted partly on the base of the petiole, c. 1 by 1¼ cm. Leaves 4—5-jugate. Leaflets medium-sized, coriaceous, margin entire to scattered dentate to the apex, lower side densely tomentose and with strongly prominent nervation.

Typical specimens of this form are only known from SE. Borneo. In Sumatra and the Malay Peninsula many specimens are intermediate between this form and f. *littorale.*

e. forma **rufum** (Benn.) Leenh., *nov. stat.* — *C. rufum* Benn.

Type: Malacca, Dec. 5, 1865, *Maingay 1434* = *Kew distr. 301,* ♂, lectotype (K; isotypes in CAL, L).

Habit stout. Stipules large, subpersistent, inserted partly on the petiole, with repandous margin. Leaves 4—6-jugate. Leaflets large, oblong-lanceolate, coriaceous, bullate, characteristic red-brown when dry; base rounded to slightly cordate; margin closely double-toothed; lower side densely tomentose and with very prominent nervation. Flowers large, ♂ ones with a capular disk. Fruits large, relatively narrow; calyx flat and circular.

This form is most closely related to f. *tomentosum*; it is rather abundant on the Malay Peninsula, furthermore it is known from Sumatra.

Indo-China. Annam: *Poilane 4603* (b), *29499* (b).

Sumatra. *Bartlett 7048* (d); *Beguin 550* (aff. d); *Endert E 816* (aff. e); *Forbes 2809* (aff. a); *FRI. bb. 91 (van Zon 31)* (aff. a), *bb. 2787 (Renwarin 73)* (aff. b), *bb. 2901 (Chairoeddin 11)* (aff. b), *bb. 5668 (Daoed 10)* (aff. a), *bb. 6247*, *bb. 8493 (Ostwald 58)* (aff. a), *bb. 15561* (a—d), *bb. 22365* (aff. d), *bb. 23569* (aff. d), *bb. 24041* (aff. d), *bb. 31722* (aff. d), *bb. 31940* (aff. d), *bb. 32072* (aff. d), *bb. 32993 (Soegihan 3)* (e), *154 T 3P 421 (Dorst)* (aff. d), *154 T 3P 595 (v. d. Zwaan)* (aff. d); *Grashoff 308* (aff. a); *Koorders 10278 β* (b); *Korthals 1167* (b), *1275* (type *C. glaucum* Bl.) (b); *Krukoff 244* (aff. d), *289* (d); *Lambach 1242* (aff. a); *Meijer 3315* (a—d), *4085* (aff. a), *4223* (a—d); *N.N. Herb. Billiton 14* (aff. a); *Rahmat 8031* (e), *8079* (aff. e), *9255* (a—d); *Teysmann HB 704* (type *C. serricuspe* Miq.) (aff. a); *Yates 1689* (e), *2581* (d).

Malay Peninsula. *Burkill 1245* (aff. *C. patentinervium*); *Burkill & Haniff 17074* (aff. b); *Cantley 155* (aff. e), *5845* (a—b); *Curtis 803* (b), *862* (b), *959* (b), *2708* (b), *in herb. W 1891 no. 2486* (b); *Derry 945* (aff. a), *1220* (aff. a); *Fox 12731* (aff. b); *Griffith Kew distr. 1141* (type *C. bennettii* Engl.) (d), *Kew distr. 1142* (type *C. purpurascens* Benn.) (b), *Kew distr. 1143* (syntype *C. rufum*) (e), *Kew distr. 1145* (aff. a); *Hullett 76* (a—d); *KEP. 760 (Speldewinde)* (e), *911 (Hamid)* (aff. a), *2124 (Bonar)* (a—d), *3552 (Lambak)* (aff. a—d), *3881 (Ahmad)* (a—d), *5055 (Ahmad)* (e), *5670 (Mitchell)* (e), *7831 (Burkill & Holttum)* (a—d), *10570 (Hamid)* (e), *10771* (e), *10796* (aff. a), *11696 (Ahmad)* (a—d), *12605 (Strugnell)* (aff. b), *12731* (b), *14980 (Mahamad)* (aff. a—b), *17854 (Meh)* (e), *23237 (Sow)* (e), *23409 (Kalong)* (a—d), *24976 (Hamid)* (a—d), *27399 (Kedah)* (e), *27894 (Strugnell)* (e), *28377 (Walton)* (e), *28378* (e), *30865 (Symington)* (aff. e), *32392 (Hamid)* (e), *33855 (Hamid)* (b), *34112 (Tasi)* (aff. b), *34113 (Tasi)* (a—b—d), *38127 (Symington)* (e), *38377* (e), *39774 (Buyong)* (e), *42133 (Mat Bin Din)* (transition to *C. patentinervium*), *42440 (Hassan)* (aff. a), *42539 (Abdullah)* (aff. a, transition to *C. patentinervium*), *44702 (Symington)* (e), *44924 (Symington)* (e), *45022 (Symington)* (a—b), *53690 (Jaya)* (b), *56735 (Symington)* (aff. b), *62879 (Hamid)* (aff. d), *64104* (b), *64162 (Sudin)* (? e), *66390 (Shariff ben Omar)* (e), *70143* (a—d), *71339* (b), *73533* (e), *73778 (Ali)* (a—b); *King's coll. 345* (a—d), *1039* (e), *4026* (b), *4330* (aff. a), *5076* (e), *6097* (e), *6101* (a—d), *6181* (b), *7610* (aff. a—b), *7885* (b), *8004* (e), *10333* (e), *10601* (e), *10722* (aff. b); *Maingay 1439 = Kew distr. 300* (a—d), *1869 = Kew distr. 300* (a—d), *Kew distr. 301* (lectotype *C. rufum* Benn.) (e); *Ridley 351* (b), *421* (b), *1812* (a—d), *1867* (a—d), *5581* (aff. b), *6358* (aff. a), *9405* (b), *13511* (a—d); *Scortechini 175* (b), *1320* (e), *2039* (e), *2081* (a—d), *2089* (e); *SF. 3283 (Burkill)* (b), *11337 (Nur)* (a—b), *17034 (Burkill & Haniff)* (a—d), *21895 (Henderson)* (aff. a), *28501 (Corner)* (a—d), *28555 (Corner)* (a—b), *29011 (Corner)* (b), *29028 (Corner)* (b), *29327 (Corner)* (a—b), *30404 (Corner)* (a—d), *31770 (Kiah)* (a—d), *32630 (Nur)* (aff. a), *33553 (Corner)* (a—d), *34955 (Corner)* (a—d), *36493 (Ngadiman)* (e), *36827 (Ngadiman)* (a—d), *37071 (Corner)* (b), *39662 (Sinclair)* (aff. e), *40089 (Sinclair)* (a—d), *40361 (Sinclair)* (b), *40663 (Sinclair)* (a—d); *Teruya 1010* (aff. a); *Wallich 9046* (type *C. secundum* Benn.) (b); *Wray Jr. 1434* (e), *3325* (e), *3641* (e), *4175* (e).

Java. *Blume 1736* (type) (a); *Forbes 523* (aff. a); *FRI. Ja 6443 (Utja & Wasijat)* (aff. a), *Ja 6640 (Wasijat)* (aff. a); *Hildebrand 19* (? a); *Horsfield 1328* (type *C. serrulatum* Miq.) (aff. a); *Kalshoven 46* (aff. a); *Koorders (all β.-numbers) 967* (aff. a), *969* (? a), *970* (? a), *973* (aff. a, transition to *C. patentinervium*), *976* (? a), *12527* (a—b), *15669* (a—b), *22189* (a—d), *23944* (a—b), *23975* (aff. a), *24770* (aff. a), *26862* (aff. a), *29963* (aff. a), *33954* (a); *Korthals in herb. L 898. 319—314* (a).

Borneo. *Beccari PB 1970* (type *C. pruinosum* Engl.) (c), *PB 2650* (type

C. giganteum Engl.) (aff. e), *PB 3276* (type *C. acutum* Engl.) (probably intermediate between a and *C. patentinervium* Miq.); *Endert 3638* (aff. a—b); *FRI. bb. 12065* (d), *bb. 13015* (aff. d), *bb. 16771* (a—d), *bb. 17743* (a—d); *Haviland 2850* (type *C. flavum* Ridl.) (? d), *2855* (e), *2855b* (e); *KEP. 34459* (*Flemmich*) (aff. d); *Korthals? in herb. L 898. 319—381* (type *C. tomentosum* Bl.) (d.); *Kostermans 4102* (aff. a), *4337* (a—c—d), *6603* (aff. a—d), *6720* (d), *7142* (d), *7458* (a—d), *7521* (a—d), *7529* (d), *7580* (a—d), *9818* (d); *NBFD. 15133* (*Wood*) (aff. a), *16269* (*Wood*) (d), *16844* (*Wood*) (e), *16933* (*Wood & Sisiran*) (aff. d), *17189* (*Wood*) (d), *17247* (*Wood*) (d).

cultivated:

Hort. Bot. Bogor VI B 27 (type *C. pseudocommune* Hochr. var. *subelongatum* Hochr.) (aff. a—b), *VI B 30* (aff. a), *VI B 37* (type *C. pseudocommune* Hochr.) (aff. b), *VII E 1* (? d); *Hort. Bot. Singapore Nur 99* (aff. d), *Nur 1512* (a—b), *Nur 2282* (aff. d).

Ecology: Rain-forests on dry or swampy soils, under everwet or (in E. Java) subseasonal conditions, mostly at low altitudes, rarely up to 2000 m. *Fl.* mainly Nov.—Apr., *fr.* mainly May—Sept.

Wood anat.: Beekman, Med. Proefst. Boschw. 5 (1920) 56; Desch, Mal. For. Rec. 15^1 (1941) 66 (hand lens); Moll & Janssonius, Mikr. Holzes 2 (1908) 107; Webber, Lilloa 6 (1941) 450.

Uses. The wood is used for house-building, though it is rather soft. The resin is used as a *damar;* in Indo-China it is said to be very sought after by the Chinese as a medicine against the itch.

2. Canarium latistipulatum Ridley, 1930, 81; Lam, 1932a, t. 5 f. 15, t. 15 f. 119a; 1932b, 508, t. 13 f. 86; Leenhouts, 1956, 258. — *C. littorale* (*non* Bl.) Lam, 1929, 116.

Type: Borneo, Sarawak, near Kuching, Febr. 20, 1893, *Haviland & Hose 2245*, ♂ (K; isotype in SAR).

Tree up to 30 m high. *Branchlets* c. ½ cm thick, glabrescent; pith with a peripheral cylinder of vascular strands appressed to the wood. *Stipules* subpersistent, inserted on the base of the petiole (up to 2½ mm high), rounded-ovate, 1—2 by 1—1¾ cm, margin minutely crenulate. *Leaves* 3—5-jugate. *Leaflets* oblong-lanceolate, 7—17 by 4—7 cm, chartaceous, subglabrous; base broadly cuneate (to rounded); margin serrate or dentate; apex abruptly rather long and slender acute-acuminate; nerves 9—13 pairs (angle 60—70°), slightly curved, distinctly arching close to the margin (often nearly transverse to the marginal nerve). *Inflorescences* (♀ unknown) terminal, laxly thyrsoid, 15—30 cm long, glabrescent. *Flowers* (♂) 1¼ cm, outside pulverulent. *Calyx* 3—5 mm high. *Stamens* glabrous, slightly connate at the base, sometimes adnate to the disk. *Disk* cupular, thick and fleshy, 1—2 mm high, glabrous, without pistil. *Infructescences* 5½ cm, densely tomentose, with 3 fruits; calyx funnel-shaped, triangular, 7 by 11 mm. *Fruits* unknown.

Distribution: Borneo (Sarawak and Br. N. Borneo).

BORNEO. *Elmer 21767; Haviland & Hose 2245* (type); *NBFD 7011 (Puasa)*, *SH. 10810 (Majuyap)*, *17245 (Wood)*.

Ecology: Lowland forest up to 150 m, apparently rare. *Fl.* Dec.—Febr., *fr.* July.

Note. Closely related to *C. littorale* and probably also to *C. patentinervium*. Especially characterized by its stipules and nervation, and moreover differing from *C. littorale* in its ♂ flowers with slightly connate stamens and more complete reduction of the pistil. Furthermore related to *C. kinabaluense,* which is a coarser species, however.

3. **Canarium perlisanum** Leenhouts, 1955b, 186; 1956, 258. — *C. ? purpurascens* (*non* Benn.) Henderson, 1939, 39.

Type: Malay Peninsula, Perlis, Kaki Bukit, alt. 70 m, April 16, 1938, *SF. 35311* (*Kiah*), ♂ (SING).

Tree *c.* 10 m. *Branchlets* ½ cm thick, glabrous; pith with a peripheral cylinder of small vascular strands. *Stipules* caducous, inserted on the petiole ½—1 cm from its base, scars 3 mm long. *Leaves* 2-jugate, glabrous. *Leaflets* subsessile, broadly-elliptic, 11—16 by 5—7 cm, chartaceous; base rounded; margin crenulate, specially near the apex; apex gradually, long and broadly blunt-acuminate; nerves 14—18 pairs (angle c. 50°), straight, gradually arching close to the margin. *Inflorescences* (♀ unknown) axillary, narrowly thyrsoid, up to *c.* 13 cm long, most of the flowerclusters nearly sessile, glabrescent. *Bracts* concave. *Flowers* (♂) 8 mm, outside thinly tomentose. *Calyx* 4 mm high. *Stamens* glabrous, filaments halfway connate. *Disk* cylindrical, 6-lobed, 1 mm high, thinly pilose on the conical upper surface, with a central canal; no pistil. *Infructescences* and *fruits* unknown.

Distribution: Malay Peninsula (Perlis), once collected.

MALAY PENINSULA. *SF. 35311* (*Kiah*) (type).

Ecology: Limestone hill, 70 m, *fl.* April.

Note. Taxonomically a rather remarkable species. Apparently related to *C. littorale,* though the axillary inflorescences and the connate stamens are quite unusual in this section, as is the combination of rather many nerves and stipules which are inserted on the petiole.

4. **Canarium patentinervium** Miquel, 1861, 526; Kurz, 1875, 142, *sphalm. patentissimum*; Engler, 1883, 148; Hochreutiner, 1904, 59, *incl. var. genuinum* and *var. meizocarpum*; Guillaumin, 1909a, f. $22^{3,7}$; Heyne, 1927, 878; Lam, 1931, t. 5 f. 11, t. 6 f. 29c; 1932b, 506; Cretzoiu, 1934, 267, *incl.* also *var. nitidum;* Leenhouts, 1956, 258. — *C. subrepandum* Miquel, 1861, 525. — *C. nitidum* Bennett, 1875a, 533; 1875b, 103; Engler, 1883, 108; King, 1894b, 251; Ridley, 1900a, 58; 1922, 373; Burkill, 1935, 431. — *C. parvifolium* Bennett, 1875a, 536; 1875b, 104; Engler, 1883, 140; King, 1894b, 241. — *C. ? littorale* (*non* Bl.) Ridley, 1922, 375. — *Fig. 15.*

Type: Sumatra, Palembang, *Teijsmann HB 3736,* fr. (U; isotype in L).

Tree 12—40 m by 20—50(—180?) cm. *Branchlets* ½ cm thick, glabrescent; pith with a peripheral cylinder of rather large vascular strands and mostly some scattered small ones in the central part. *Stipules* caducous, inserted at the conjunction of branchlet and petiole, about reniformous, 3—5(—12) mm. *Leaves* (2—)3—4(—5)-jugate, 15—37 cm long, glabrous. *Leaflets* ovate to oblong-lanceolate, 4¼—6½—18 by 1½—3½—7¼ cm, coriaceous, shining beneath; base subequilateral, broadly cuneate (to subcordate); margin entire, rarely minutely dentate near the apex; apex gradually to subabruptly, shortly and bluntly acuminate; nerves 5—15 pairs (angle 60—70°), widely spaced, slightly curved, distinctly arching at some distance from the margin, not very conspicuous above; reticulations nearly inconspicuous. *Inflorescences* terminal, some main branches sometimes in the upper leaf-axils, ♂ ones laxly thyrsoid, (7—)15—20(—30) cm long, thinly tomentose, many-flowered; ♀ ones more dense, 2—10 cm long, more densely tomentose and few-flowered. *Flowers* ¾—1 cm, pubescent outside. *Calyx* nearly truncate, in ♂ flowers 2½—4 mm high, in ♀ ones 6 mm. *Stamens* 6, glabrous, in ♂ flowers slightly connate at the base and sometimes adnate to the disk, in ♀ flowers rather strongly reduced, inserted on the disk. *Disk* in ♂ flowers pistilloid, globular, sometimes stalked, tapering into a long style-like appendix, in total 2 mm high; in ♀ flowers adnate to the receptacle, if this is concave; always glabrous. *Pistil* glabrous. *Infructescences* 6—8 cm long, densely and shortly, ferruginously woolly-tomentose, with 1—2(—4) fruits; calyx flat, 3-lobed, 11—14 mm diam. *Fruits* ellipsoid to obovoid, round to rounded-triangular in cross-section, glabrous, 3—6 by 1¾—3 cm; pyrene smooth; lids 3—5 mm thick. *Seeds* 1—3; sterile cells more or less reduced.

Distribution: Sumatra, Malay Peninsula, Banka, Anambas Islands, Borneo.

SUMATRA. *Diepenhorst HB 2336* (type *C. subrepandum* Miq.); *Forbes 2191, 2671, 2991; FRI. bb. 30119, S.W.K./I-26; Koorders 10678β.; Krukoff 4079, 4371* (transition to *C. littorale f. purpurascens*); *Lambach 1357; Teysmann HB 3736* (type). — Banka: *Hort. Bot. Bogor VI B 58* (type *C. patentinervium var. meizocarpum* Hochr.).

MALAY PENINSULA. *Alvins 159; Derry 12, 20, 58, 290; Goodenough 1342, 1755, 1868, 3799; Griffith 91, 1068, 1140, 1147* (syntype *C. nitidum* Benn.); *Hassan 1219; KEP. 865 (Hamid), 1422 (Burkill), 1816 (Rahman), 1867 (Kinsey), 20101 (Durant), 20413 (Mahamud), 23406 (Kalong), 23807 (Osman), 28397 (Walton), 28521 (Osman), 43496 (Browne), 43499 (Browne), 57327 (Lande), 66525 (Sow-Lindong), 67612 (Awang Bin Bulat), 69803, 70343 (Wyatt Smith), 70491 (Sow-Lindong), 71296; King's coll. 2618, 4263, 4604, 5658, 6998, 7870, 10916; Maingay 1532 = Kew distr. 353* (type *C. parvifolium* Benn.), *3116 = Kew distr. 350* (syntype *C. nitidum* Benn.); *Ridley 1868, 3799, 4584, 4729, 4734, 5007, 5081, 5981, 6010, 8401; Scortechini 856; SF. 1422 (Burkill), 32140 (Kiah), 35965 (Kiah), 36400 (Ngadiman), 36405 (Yassin), 36906 (Ngadiman); Sukoe 7677; Wallich 8546* (syntype *C. nitidum* Benn.).

BORNEO. *FRI. bb. 20733 (Henar 161)* (transition to *C. maluense?*); *Sarawak Forest Dept. S 220* (transition to *C. littorale*), *S 4899; SF. 26846 (Carr)*. — Anambas Islands: *SF. 20409 (Henderson)* (transition to *C. littorale f. purpurascens*).

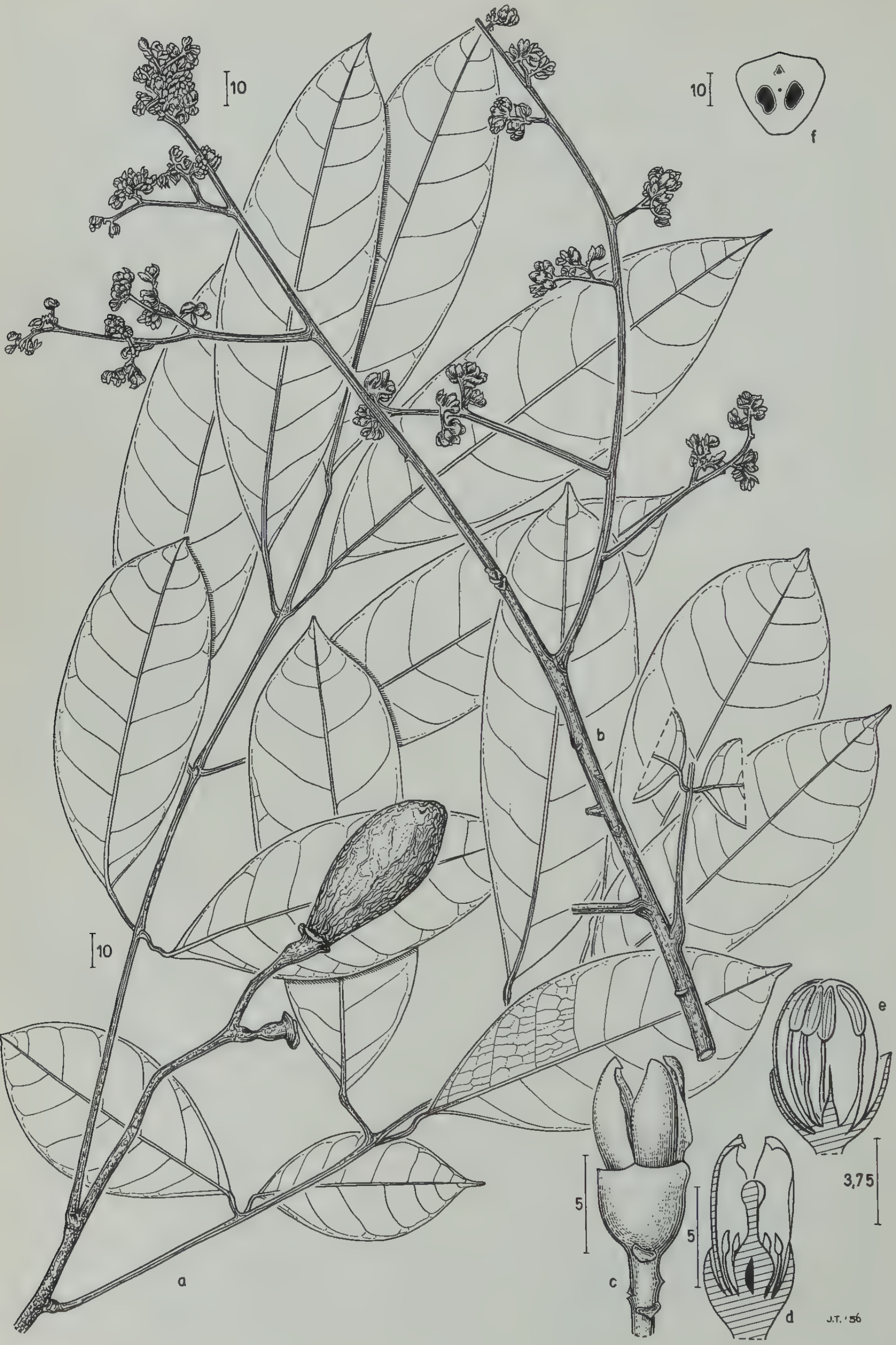
Ecology: Primary forests, up to 450 m (rarely up to 1150 m), *fl.* mainly Nov.—May, *fr.* mainly Sept.—April.

Notes. Most closely related to *C. littorale;* some intermediate specimens are known from Sumatra, Banka, and Borneo. However, the two species are nearly always quite distinguishable, specially in their leaf-characters. The leaves of the present species are very smooth, with few, widely spaced nerves, which are only slightly prominent; the reticulations are inconspicuous.

Some specimens from the Mahakam River, E. Borneo, are intermediate between this species and *C. maluense*.

In its vegetative parts very similar to the Malay Peninsular specimens of *C. caudatum,* a species with only 3 stamens in the ♂ flowers.

5. **Canarium caudatum** King, 1894b, 240; Ridley, 1922, 370; 1930, 81; Lam, 1931—32, t. 5 f. 12, t. 11 f. 57, t. 13 f. 104 m; 1932b, 443, t. 9 f. 54; Leenhouts, 1956, 259, f. 22d. — *C. pauciflorum* Ridley, 1930, 80; Lam, 1932a, t. 11 f. 55, t. 15 f. 119c; 1932b, 502, t. 13 f. 83.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Type: Malay Peninsula, Perak, Ulu Bubong, alt. c. 200 m, Jan., 1886, *King's coll. 10227,* ♂, lectotype (CAL; isotypes in A, BM, CAL, G, L).

Tree up to 18 m by 40 cm. *Branchlets* c. 3 mm thick, glabrescent; pith with a peripheral cylinder of large and small vascular strands. *Stipules* from: very caducous, inserted at the conjunction of branchlet and petiole, reniformous, c. 2 mm long, to: subpersistent, inserted on the petiole up to ¾ cm from its base, auricle-shaped, 3—5 mm long. *Leaves* 0—3(—4)-jugate, glabrous. *Leaflets* elliptic-ovate to elliptic-lanceolate, tapering at base and apex, 5½—12(—17) by 2½—5(—7¼) cm, subcoriaceous; base cuneate; margin entire; apex caudate-acuminate; nerves 7—11 pairs (angle 60—80°), curved, distinctly arching at some distance from the margin, not very conspicuous. *Inflorescences* terminal, laxly thyrsoid, thinly tomentose to glabrous, ♂ ones 10—30 cm long, ♀ ones 7—15 cm. *Flowers* subglabrous, ♂ ones 3—6 mm, ♀ ones 7—10 mm. *Calyx* subtruncate, in ♂ flowers 1—2 mm high, in ♀ ones 4 mm. *Stamens* glabrous, in ♂ flowers 3, adnate to the disk, in ♀ flowers 6, slightly confluent at the base, inserted on the disk. *Disk* in ♂ flowers consisting of 3 tomentose alternistaminal lobes, which are adnate to the rudimentary pistil, the latter being glabrous, flat, tapering into a filiformous, rudimentary style; in ♀ flowers glabrous, adnate to the receptacle and to the stamens. *Pistil* glabrous. *Infructescences* up to 15 cm long with few fruits; calyx funnel-shaped, faintly 3-lobed, 7—9 mm diam. *Fruits* spindle-shaped, triangular in cross-section, 4¾—7½ by 1¼—2¼ cm, glabrous; pyrene acutely triangular; lids c. ¼ cm thick. *Seeds* 1—2; sterile cells rather strongly reduced.

Distribution: Sumatra, Malay Peninsula, Borneo.

Taxonomy. The following two forms can be distinguished:

a. forma **caudatum.**

Stipules small, reniformous, inserted partly on the branchlet. Leaves and flowers large. Occupies the area of the species.

SUMATRA. *Koorders 21275β; Rahmat 3576, 5213; Ridley 9013.*

MALAY PENINSULA. *Hume 7584, 7659A; KEP. 2933 (Ahmad), 4730 (Foxworthy); King's coll. 4315, 8554* (syntype), *10016* (syntype), *10182* (syntype), *10227* (syntype); *Ridley 3110, 7363; Scortechini 454b, in herb. CAL 78298; SF. 19422 (Henderson).*

BORNEO. *Beccari PB 1995, herb. 2173; Haviland 1864* (type *C. pauciflorum* Ridl.); *Haviland & Hose 3181* (paratype *C. pauciflorum* Ridl.).

b. forma **auriculiferum** Leenhouts, 1955b, 181; 1956, 260.

Type: Borneo, Sarawak, near Kuching, *Haviland 2877,* ♂ (SING; isotypes in BM, K, L, SAR).

Stipules auricle-shaped, inserted on the petiole. Leaves and flowers small. Sumatra and Borneo.

SUMATRA. *Buwalda 6644* (paratype), *6773* (paratype); *Rahmat 5044* (paratype).

MALAY PENINSULA. *KEP. 70317 (Sow-Lindong)* (aff).

BORNEO. *BS. 2466 (native collector)* (paratype); *FRI. bb. 15177, bb. 17015*

Fig. 15. *C. patentinervium* — a. twig with infructescence; b. ♀ inflorescence; c. ♀ flower; d. ditto in section; e. ♂ flower, longitudinal section; f. pyrene in cross-section. (a. from *Sinclair s.n. in herb. L 950.233—393,* the fruit from *Pl. Bog. exsicc. 124;* b. from *Hort. Bog. VI B 60;* c—d. from *Ridley 6010;* e. from *Hort. Bog. VI D 16;* f. from *Forbes 2991*) (dimensions in mm).

(Joedotenojo) (aff.), *bb. 18950 (v. d. Zwaan 975)*; *Haviland 2877* (type); *Haviland & Hose 3275* (paratype); *Hose 183* (paratype), *262* (paratype), *288* (paratype).

Ecology: Primary forests, sometimes bamboo-forests, up to *c.* 250 m, *fl.* mainly April—July, *fr.* mainly Oct.

Note. The major part of the specimens can be definitely referred to one of the forms, although a few are transitional. Forma *caudatum* is, especially in the Malay Peninsula, closely resembling *C. patentinervium,* from which it differs essentially only in its 3-staminate ♂ flowers. Apart from this, the lax inflorescences and the distant caudate leaflets often characterize the species.

6. **Canarium divergens** Engler, 1883, 143; Lam, 1932a, t. 12 f. 89; 1932b, 503, t. 13 f. 84; Leenhouts, 1956, 260.

Type: Borneo, Sarawak, Mattang, July 1866, *Beccari PB 2237,* ♂ (P; isotypes FI, K).

Tree. *Branchlets* c. 1/4 cm thick, glabrous; pith with a peripheral cylinder of vascular strands and some central scattered ones. *Stipules* caducous, inserted on the base of the petiole, probably small. *Leaves* (1—)2—3-jugate. *Leaflets* oblong-lanceolate to elliptic-oblong, 5½—10½ by 2½—4½ cm, subcoriaceous, glabrous; base broadly cuneate to rounded; margin entire; apex subabruptly, broadly blunt-acuminate; nerves 8—11 pairs (angle 50—60°), straight to faintly curved, abruptly arching close to the margin. *Inflorescences* (♀ unknown) terminal and in the upper leaf-axils, broadly and very laxly thyrsoid, 10—15 cm long, with c. 12—15 flowers, subglabrous. *Flowers* (♂) 1¼ cm long, outside pubescent. *Calyx* 9 mm long. *Stamens* glabrous, often connate at base and adnate to the disk. *Disk* semiglobular to conical, 1 mm high, bearing on its top the tiny rudimentary pistil, glabrous. *Infructescences* and *fruits* unknown.

Distribution: Borneo.

BORNEO. *Beccari PB 1735, PB 2237* (type).

Note. Apparently related to *C. patentinervium.* Characterized by its laxly branched inflorescences with rather large flowers.

The specimen *Haviland & Hose 3184* possibly also belongs to this species; it is different, however, by its smaller flowers (7—8 mm) with only 4—5 stamens each. In these respects it seems to be intermediate to *C. caudatum.*

7. **Canarium kinabaluense** Leenhouts, 1955b, 182, f. 1; 1956, 260.

Type: North Borneo, near Sandakan, 1920, *Ramos 1698,* fr. (L; isotypes A, BO, BM, K, P).

Tree 20 m by 25 cm. *Branchlets* ½—¾ cm thick, often lenticellate, glabrescent; pith with a peripheral cylinder of small vascular strands. *Stipules* subpersistent, inserted on the base of the petiole, suborbicular to elliptic, ¾—2½ by ¾—2 cm, subcoriaceous, densely sericeous-pubescent to glabrous, entire to denticulate, nerves anastomosing, conspicuous. *Leaves* 2—4-jugate. *Leaflets* broadly lanceolate to ovate or elliptic, 8—15—20 by (3½—)5½—10 cm, coriaceous, glabrous; base rounded to broadly cuneate; margin crenulate to the apex; apex rather abruptly broadly acute-acuminate; nerves (8—)11—12(—19) pairs (angle variable), straight to curved, gradually arching at some distance from the margin. *Inflorescences* unknown. *Infructescences* terminal, laxly thyrsoid, 15—20 cm long, glabrescent, with *c.* 12 fruits; calyx widely funnel-shaped, 1¼ cm diam., with remnants of an annular, fimbriate disk and free stamens. *Fruits* narrowly spindle-shaped, triangular in cross-section, acute at base and apex, 6—6½ by 2—3 cm, glabrous; pyrene rounded triangular, smooth except the 3 acute angle ribs near the apex; lids 3 mm thick. *Seed* 1; sterile cells more or less strongly reduced and more or less shifted to the surface.

Distribution: North Borneo.

BORNEO. *Clemens 31612* (paratype), *31807* (paratype), *51315* (paratype); *Ramos 1698* (type).

Ecology: Altitude mostly 1000—1500 m, *fl., fr.* Dec.—Jan.

Note. Related to *C. patentinervium* and to *C. divergens;* differing from both by its large, coriaceous stipules and its coarse and stiff, often not fully entire leaflets. Furthermore related to the more slender *C. latistipulatum.* Referred by Merrill, 1922, 318, to *C. pseudocommune,* by Lam, 1932b, 498, to *C. littorale.*

8. **Canarium maluense** Lauterbach, 1920, 323, f. 1; Lane-Poole, 1925, 99; Lam, 1932a, t. 12 f. 90; 1932b, 504, t. 13 f. 85; Leenhouts, 1955b, 184, f. 5b; 1956, 260, f. 21h. — *C. lian* Lam, 1932a, 209, t. 12 f. 92, t. 15 f. 116b; 1932b, 440, t. 9 f. 52. — *C. quadrangulare* Lam, 1932a, 219, f. 104o, f. 116c; 1932b, 441, t. 14 f. 94.

Type: New Guinea, Kais. Wilh. land, Malu, alt. 50—100 m, July 30, 1912, *Ledermann 8079,* ♂ (BRSL; isotype in K).

Tree, 15—40 m high, 15—60 cm in diam. Sometimes with up to 1½ m high buttresses. *Branchlets* 3—7 mm thick, glabrescent, often lenticellate; pith rather loose, vascular strands ranging from: many scattered small ones, to: some large peripheral ones. *Stipules* ranging from: caducous, inserted at the conjunction of branchlet and petiole, scaly, 3 by 2 mm, to: persistent, inserted on the petiole up to ¾ cm from its base, auricle-shaped, up to 1¼ by 1¼ cm. *Leaves* 1—4-jugate. *Leaflets* ovate to oblong-eliptic, 4—15—25 by 3—10 cm, (sub-)coriaceous, smooth to bullate, subglabrous, rarely rather densely tomentose beneath; base broadly cuneate to subcordate, nearly equilateral; margin entire; apex rather abruptly acuminate, acumen short and blunt, often emarginate; nerves rather dense, 10—24 pairs (angle 90—60°, decreasing from base to apex), straight to faintly curved, abruptly arching at some distance from the margin. *Inflorescences* terminal and in the upper leaf-axils, thyrsoid, 1½—10 cm long, tomentose, flowers clustered. *Flowers* 3—9 mm long, outside tomentose. *Calyx* 1—4 mm high. *Stamens* 6 (in ♂ flowers a slight tendency to reduce this number), glabrous, in ♂ flowers more or less adnate to the disk, in ♀ flowers inserted on its rim. *Disk* glabrous to pilose, in ♂ flowers pistilloid or ovoid to globular, solid, ½—1 mm high; in ♀ ones adnate to the receptacle. *Pistil* partly pubescent, rarely glabrous. *Infructescences* thyrsoid, 4—10 cm long, tomentose to lenticellate, with up to 20 fruits; calyx flat to saucer-shaped, indistinctly 3-lobed, 1—1¼ cm diam. *Fruits* ovoid to ellipsoid, round (to quadrangular) in cross-section, 1¾—3 by 1—1¾ cm, glabrous; pyrene smooth, round to blunt-angular in section; lids 3—4 mm thick. *Seeds*

1(—2); sterile cells strongly reduced, sometimes (in quadrangular fruits) more or less shifted to the periphery.

Distribution: Borneo to New Guinea.

Ecology: Primary rain-forests, 0—1100 m. *Fl.* mainly June—July, *fr.* mainly Aug.—Oct.

KEY TO THE INFRASPECIFIC TAXA

1.a. Disk in ♂ flowers pistilloid, tapering into a 'style'. Pistil in ♀ flowers glabrous. Leaflets small (6—15 by 2¾—5½ cm) with 10—12(—15) pairs of nerves. *Borneo* . . . . subsp. **borneense**

b. Disk in ♂ flowers without 'style'. Pistil in ♀ flowers partly pubescent. Leaflets larger (usually 10—20 by 5—10 cm) with 11—24 pairs of nerves. *Celebes to New Guinea* subsp. **maluense** 2

2.a. Stipules inserted at the conjunction of branchlet and petiole, caducous . . 3

b. Stipules inserted on the petiole, caducous to persistent 4

3.a. Leaflets 10—25 by 6—10 cm, coriaceous, bullate, tomentose beneath. *New Guinea* f. **bullatum**

b. Leaflets 10—20 by 4½—9 cm, neither coriaceous nor bullate, glabrous. *Celebes, Moluccas* . . . . f. **celebicum**

4.a. Stipules caducous, inserted near the base of the petiole. *New Guinea* f. **maluense**

b. Stipules persistent, inserted on the petiole at some distance from its base . 5

5.a. Leaflets 1½—2½ times as long as broad. Sterile cells in the fruits not shifted to the periphery. *Moluccas* . . . . f. **lian**

b. Leaflets 3—4 times as long as broad. Sterile cells of the fruits shifted to the periphery. *New Guinea* . . . . f. **quadrangulare**

A. Subsp. **borneense** Leenhouts, 1955b, 184; 1956, 261.

Type: Borneo, Peak of Balikpapan, alt. 640 m, 14-7-1952, *Kostermans 7525*, ♂ (holotype in L, isotypes in BO, K).

Stipules caducous, small, inserted at the conjunction of branchlet and petiole. Leaflets elliptic, 6—15 by 2¾—5½ cm (about 2½ times as long as broad); nerves 10—12(—15) pairs. Inflorescences laxly thyrsoid, few-flowered. Flowers 8—9 mm long. Stamens slightly connate at base. Disk in ♂ flowers pistilloid, gradually narrowed into a filiformous rudimentary style. Pistil glabrous. Infructescences and fruits unknown.

Distribution: Borneo.

BORNEO. East Borneo: *Kostermans 7148* (paratype), *7362* (paratype), *7525* (type), *7591* (paratype).

Ecology: On sandstone or sand, alt. up to 700 m. *Fl.* June—July.

B. Subsp. **maluense**. — *C. lian* H. J. Lam. — *C. quadrangulare* H. J. Lam.

Stipules variable. Leaflets ovate to oblong-eliptic, 4—15—25 by 3—10 cm; nerves 11—24 pairs. Inflorescences not very lax, more-flowered. Flowers 3—6 mm long. Stamens more or less adnate to the disk, not mutually connate. Disk in ♂ flowers not pistilloid. Pistil partly pilose.

Distribution: Celebes to New Guinea.

Taxonomy. This subspecies is rather variable, mainly regarding the insertion of the stipules, the shape of the leaflets, the number of the nerves, and the reduction of the sterile cells in the fruits; some of these characters, particularly those of the stipules and the fruits, are rather distinctly grading from west to east. On account of these variations, the following 5 *formae*, though not sharply delimited, are distinguishable:

a. forma **celebicum** Leenhouts, 1955b, 184.

Type: Celebes, Malili, Lampea, alt. 50 m, 19-4-1929, *FRI. bb. 13573*, ♂ (L; isotype in BO).

Stipules caducous, inserted at the conjunction of branchlet and petiole, small, reniformous. Leaflets 10—20 by 4½—9 cm, 2—3 times as long as broad; nerves 14—18 pairs. Fruits with moderately reduced sterile cells.

Distribution: Celebes, Batjan.

b. forma **maluense.**

Stipules caducous, inserted on the base of the petiole, small. Leaflets 12—16 by 4½—6½ cm, 2½—3 times as long as broad; nerves 18—23 pairs. Fruits with moderately reduced sterile cells.

Distribution: New Guinea (*incl.* also Schouten Island).

c. forma **lian** (H. J. Lam) Leenhouts, *nov. stat.* — *C. lian* H. J. Lam.

Type: Moluccas, Morotai, E. of Pilowo, Guguti, alt. *c.* 60 m, 22-6-1926, *Lam 3531*, ♀, lectotype (BO; isotype in L).

Stipules persistent, inserted on the petiole, auricle-shaped. Leaflets 14—21 by 7—10½ cm, 1½—2½ times as long as broad, somewhat more pilose; nerves 18—21 pairs, prominent beneath. Fruits with moderately reduced sterile cells.

Distribution: Morotai, Batjan.

d. forma **bullatum** Leenhouts, 1955b, 184.

Type: W. New Guinea, Idenburg river, Bernhard Camp, alt. 900 m, 10-3-1939, *Brass & Versteegh 13136*, fr. (L; isotype in A).

Stipules caducous, inserted at the conjunction of branchlet and petiole, small. Leaflets 10—25 by 6—10 cm, 1½—2½ times as long as broad, coriaceous, bullate, more or less densely tomentose beneath; nerves 18—25 pairs, prominent beneath. Fruits with strongly reduced sterile cells, which are in the normal position.

Distribution: New Guinea, mostly at about 1000 m alt.

e. forma **quadrangulare** (H. J. Lam) Leenhouts, *nov. stat.* — *C. quadrangulare* H. J. Lam.

Type: W. New Guinea, Manokwari, Pami-colonisation, alt. 25 m, 17-9-1931, *FRI. bb. 15889* (*Tetelepta 5*), fr., lectotype (BO; isotype in L).

Stipules persistent, inserted on the petiole, auricle-shaped. Leaflets 12—24 by 4—8 cm, 3—4 times as long as broad; nerves 15—20 pairs. Fruits with very reduced sterile cells, which are shifted to the periphery, and sometimes are slightly prominent on the surface of the pyrene.

Distribution: W. New Guinea (Vogelkop).

Celebes. *FRI. bb. 13573* (a: type), *bb. 26015* (a—b), *Cel./II-204* (*Waturanadang 643*) (a—e), *Cel./II-413* (*Waturanadang 479*) (a: paratype); *Kjellberg 1837* (a: paratype), *2012* (a: paratype).

Moluccas. Morotai: *Lam 3531* (type *C. lian* H. J. Lam) (c); *Main & Aden 1313* (aff. b), *herb. BO 54121 & 54126* (*herb. L 951. 125—083/4*) (aff. b). — Batjan: *FRI. bb. 23160* (*De Haan 40*) (c), *bb. 23178* (aff. a); *unknown coll. VI* (*herb. BO 125210/1*) (syntype *C. lian* H. J. Lam) (aff. c). — Aru Islands: *FRI. bb. 25306* (b—e).

NEW GUINEA. *Bäuerlen 467* (b—e); *Beccari PP 722* (e); *Brass 8614* (b—c), *8984* (aff. b); *Brass & Versteegh 12586* (d: paratype), *13136* (d: type); *BW. 2129* (*Mangold 73*) (b—c), *2672* (*Schram*) (b); *Clemens 1326* (aff. d), *2084* (aff. d); *FRI. bb. 15886* (*Tetelepta 2*) (syntype *C. quadrangulare* H. J. Lam) (e), *bb. 15889* (*Tetelepta 5*) (lectotype *C. quadrangulare* H. J .Lam) (e), *bb. 25029* (b), *bb. 28923* (b—e), *bb. 30790* (b), *bb. 31112* (*Van Eechoud 48*) (d: paratype), *bb. 31127* (*Van Eechoud 66*) (d: paratype); *Lane-Poole 244* (b); *Ledermann 6984* (paratype) (b), *7969* (paratype) (b), *8079* (type) (b), *9419* (aff. d), *10481* (paratype) (b); *NGF. 2754* (b—d), *2845* (*Heather*) (b); *Van Royen 4007* (e).

Notes. *Morphology and Taxonomy.* This species is a most interesting one, as is apparently forms a link between the W. Malaysian *C. littorale, patentinervium,* and allies on the one side, and the species with auricle-shaped stipules from the Moluccas and more eastern localities, *viz. C. sylvestre, piloso-sylvestre, salomonense, lamii,* and *harveyi,* on the other side. Many of the differences between these two groups of species — especially the differences in the stipules (caducous and inserted at the base of the petiole in the western species, persistent, inserted on the petiole, and auricle shaped in the eastern ones) and in the fruits (sterile cells moderately reduced in the western species, usually strongly so in the eastern ones), moreover the reduction of the ovary and of the number of stamens in the ♂ flowers — are more or less grading from west to east within *C. maluense,* which consequently is a very variable species.

The most primitive form in these respects is in my opinion subsp. *borneense,* which is moreover the most western form and the only one west of Wallace's line. Especially striking in this subspecies is the possession of an ovariodisk with 'style' in the ♂ flowers, and the indubitable relationship to *C. patentinervium.* From the latter it differs mainly in its more lax inflorescences and leaves. By these characters subsp. *borneense* strikingly resembles *C. caudatum* f. *auriculiferum.* From this it differs, however, by its stipules (caducous and inserted at the base of the petiole, instead of the persistent auricle-shaped ones, inserted on the petiole, of the latter) and the number of stamens in the ♂ flowers (6 instead of 3). Though it would be quite justified to consider subsp. *borneense* as a slightly different local population of *C. patentinervium,* I prefer to combine it with *C. maluense,* since I consider subsp. *borneense* the typological point of issue of *C. maluense.* Moreover, the apparently direct bridging of Makassar Strait is more strikingly demonstrated in this way.

The relationship of the western forms of *C. maluense* also is clear from the fact, that H. J. Lam, 1932b, *l. c.,* refers the Celebes-specimens for the greater part to *C. littorale*; one specimen he referred to *C. commune.*

Forma *bullatum,* in some characters rather primitive and probably closest to f. *celebicum,* forms a rather isolated, mainly mountainous, population in the eastern part of the area.

Possibly the most advanced form is f. *quadrangulare,* in its vegetative parts close to *C. sylvestre,* mainly differing by its very peculiar fruits. In *Van Royen 4007,* however, the sterile cells of the fruit are not shifted to the periphery, and in another specimen they are shifted in a different degree, even in a single fruit.

C. salomonense also shows some affinities to *C. maluense,* especially f. *lian;* it is distinctly different by its small leaflets.

The most striking character of *C. maluense* is the symmetry of the leaflets, especially of the base, and the regularity of the nervation.

9. **Canarium megacarpum** Leenhouts, 1955b, 186, f. 3; 1956, 261, f. 21 d—e.

Type: West New Guinea, W. Rauna, April 4, 1937, *FRI. bb. 22547* (*Salverda 561*), fr. (BO; isotype L).

Tree 35 m by 40 cm. *Branchlets* 1¼ cm thick, glabrescent; pith with many scattered small vascular strands. *Stipules* caducous, inserted on the base of the petiole, reniformous, 5 by 8 mm, densely tomentose, margin denticulate. *Leaves* 4—5-jugate. *Leaflets* ovate to elliptic-oblong, 15—17½(—19) by 5—7(—8½) cm, subcoriaceous, shortly fulvous-tomentose on midrib above and on all nerves beneath; base rounded to truncate; margin entire; apex rather abruptly shortly acute-acuminate; nerves 17—22 pairs (angle 55°), straight to faintly curved, only in the apical part distinctly arching. *Inflorescences, flowers* and *infructescences* unknown. *Fruits* ovoid, triangular in cross-section, 7—8 by 5 cm, glabrous; pericarp ½ cm thick, fibrous; pyrene sharply 3-winged, lids concave, scaberulous, 3—3½ mm thick. *Seeds* 2; sterile cell moderately reduced.

Distribution: West New Guinea.

NEW GUINEA. *FRI. bb. 22547* (*Salverda 561*) (type).

Ecology: Primary forest. *Fr.* April.

Note. Related to *C. maluense;* specially characterized by its fruits.

10. Canarium lamii Leenhouts, 1955b, 184, f. 2; 1956, 261.

Type: West New Guinea, Holtekang near Hollandia, alt. 2 m, Oct. 28, 1954, *BW. 1607* (*Brouwer*), fr. (L).

Tree 20—35 m by 50 cm. *Branchlets* 6—7 mm thick, scurfy; pith with a peripheral cylinder of small vascular strands. *Leaves* 3-jugate, glabrous. *Stipules* subpersistent, inserted on the petiole, 1—1½ cm from its base, decurrent, oblique-obovate, 1¼—2 by 1 cm, rather stiff. *Leaflets* ovate to lanceolate, 11—18 by 6—7 cm, coriaceous; base slightly oblique, rounded; margin entire; apex rather abruptly, shortly and bluntly acuminate; nerves 10—12 pairs (angle 60—80°), moderately curved, more or less distinctly arching close to the margin. *Inflorescences* and *flowers* unknown. *Infructescences* terminal, small, with 1 fruit; calyx flat, orbicular, 1¾ cm diam. *Fruits* ovoid, 6 by 4 cm, glabrous; pericarp ½—¾ cm thick, fibrous; pyrene smooth, rostrate at the apex, in cross-section rounded triangular; the lids ¾ cm thick, very hard. *Seeds* 1—2.

Distribution: West New Guinea.

NEW GUINEA. *BW. 1415* (*Koster*), *1468* (*Koster*), *1607* (*Brouwer*) (type), *1697* (*Schram*), *4636* (*Versteegh*).

Ecology: Primary and secondary forest at very low alt.; *fl.* and *fr.* in Oct.

Note. The affinities of this species remain uncertain. On the one side it seems to show some relationship with *C. maluense* and especially with *C. harveyi*; on the other side it reminds one of *C. indicum*. Apart from the differences in the stipules, the fruits of the present species and *C. indicum* are distinctly different, however, those of *C. lamii* being bigger, with a very thick and apparently fibrous pericarp and very thick mesocarpal lids; moreover the pedicel in the infructescence is much thickened and the calyx reduced to a narrow ring around it, in contradistinction to *C. indicum* in which the pedicel is slender and the calyx much wider and spreading. The leaflets of *C. indicum* are nearly always distinctly widest in the basal half, those of *C. lamii* have their greatest width in the middle as is usual in the *maluense*-group. The flowers may prove to be decisive.

11. **Canarium sylvestre** Gaertner, 1791, 99, t. 102; De Candolle, 1825, 79; Heyne, 1927, 879; Lam, 1932a, t. 11 f. 54, t. 13 f. 104f, t. 15 f. 116a; 1932b, 442, t. 9 f. 53; Leenhouts, 1956, 261, f. 22e; *non* Blume, 1850, 217 (= *C. denticulatum* Bl.). — *C. sylvestre alterum* Rumphius, 1741, 155, t. 49. — *C. sylvestre* Willdenow, 1806, 760; Roxburgh, 1814, 49; 1832, 137, *excl. syn. Pimela nigra et C. pimela.* — *C. simplicifolium* Engler, 1883, 146. — *C. branderhorstii* Lauterbach, 1920, 322. — *C. appendiculatum* Lauterbach, 1920, 331.

Type: Moluccas, Morotai, Sangowo, 1949, *Main & Aden in herb. L 951. 125—085,* fr., neotype (L; isotype in BO).

Tree *c.* 20 m by 40 cm, sometimes buttressed. *Branchlets c.* ½ cm thick, glabrescent; pith with some large peripheral vascular strands, sometimes also some central ones. *Stipules* persistent, inserted on the petiole at ¼—1 cm from its base, auricle-shaped, 1½—4 mm long, thinly tomentose. *Leaves* 0—3-jugate, glabrous. *Leaflets* oblong-lanceolate to elliptic-oblong, 8—21 by 3½—10 cm, chartaceous, reddish-brown to cinnamomeous when dry; base cuneate; margin entire; apex subabruptly, long, and slender, blunt-acuminate; nerves 8—15 pairs (angle 60—70°), faintly curved, distinctly arching near the margin. *Inflorescences* (♀ unknown) terminal and sometimes in the upper leaf-axils, thyrsoid, 4—32 cm long, glabrous. *Flowers* (♂) *c.* 3 mm long, glabrous outside. *Calyx* 2—3 mm high. *Stamens* 6—3, free, glabrous. *Disk* cushion-shaped, solid, *c.* 1 mm high, glabrous. *Infructescences* terminal, narrowly thyrsoid, 6—7 cm long, with few fruits; calyx flat, triangular to nearly orbicular, 9—12 mm diam. *Fruits* ovoid, 3—5½ by 1½—2¾ cm, round to bluntly triangular in cross-section, glabrous; pyrene smooth with a blunt rib in the apical part of each angle; lids 2½—3½ mm thick. *Seeds* 3—1; sterile cells mostly slightly reduced.

Distribution: Moluccas (Morotai, Buru, Ceram, Ambon), New Guinea.

MOLUCCAS. Morotai: *Main & Aden in herb. L 951.125—085* (neotype). — Buru: *FRI. bb. 22836.* — Ceram: *Buwalda 5608, 5612*; *FRI. bb. 25809, bb. 25826.* — Ambon: *Buwalda 6125*; *FRI. bb. 10132, bb. 25978*; *Hombron s.n.* (type *C. simplicifolium* Engl.); *Robinson Pl. Rumph. Amb. 378, Pl. Rumph. Amb. 379; Warburg 17396* (paratype *C. appendiculatum* Lauterb.).

NEW GUINEA. *Aët 694*; *Branderhorst 343* (type *C. branderhorstii* Lauterb.); *Brass 7088*; *FRI. bb. 22556, bb. 25082, bb. 30622*; *Ledermann 9132* (type *C. appendiculatum* Lauterb.); *Van Royen 3205.*

Ecology: In primary mixed and sagu forests at low altitudes, up to 850 m; *fl.* mainly Aug., *fr.* April—Sept.

Uses. The wood, the resin, and the seeds are sometimes used; they are of minor importance.

Notes. Blume, *l. c.*, misinterpreted a specimen of *C. denticulatum*

f. *fissistipulum* as belonging to this species, and accordingly erroneously recorded *C. sylvestre* from Sumatra. In this he was followed by Miquel (1859 & 1861) and by Engler (1883).

This species is most close to *C. maluense* f. *quadrangulare* — which is distinctly different in its fruits — and to *C. piloso-sylvestre* — differing by its pubescence.

12. **Canarium piloso-sylvestre** Leenhouts, 1955b, 186; 1956, 262. — *Fig. 16.*

Type: West New Guinea, Mc Cluer Bay, Anakasi near Babo, alt. 50 m, May 16, 1941, *Aët (exp. Lundquist) 138*, ♂ (L; isotype in BO).

Large tree. *Branchlets* c. 4 mm thick, long remaining densely ferruginously woolly pubescent; pith with a number of small vascular strands, most of them arranged into a peripheral cylinder. *Stipules* subpersistent, inserted on the petiole up to 8 mm from its base, auricle-shaped to lingulate, up to 6 by 3½ mm, stiff, pilose. *Leaves* 1—2-jugate. *Leaflets* elliptic to obovate, 10—12 by 4½—6 cm, chartaceous, reddish-brown when dry, glabrous above, sparsely pilose beneath; base equilateral, cuneate; margin entire; apex rather abruptly long and slender blunt-acuminate; nerves 11—12 pairs (angle 60—70°), curved, distinctly arching at c. 3 mm from the margin, slightly sunken above. *Inflorescences* (♀ unknown) terminal, narrowly thyrsoid, c. 15 cm long, densely woolly pubescent. *Flowers* (♂) 8 mm long, glabrous outside. *Calyx* ¼ cm high, subtruncate. *Stamens* 3, slightly adnate to the disk, glabrous. *Disk* cylindrical, solid, 3-lobed, 2 mm high, glabrous. *Infructescences* and *fruits* unknown.

Distribution: West New Guinea.

NEW GUINEA. *Aët 138* (type).

Ecology: Alt. 50 m, *fl.* May.

Note. Though apparently very closely related to *C. sylvestre*, this specimen probably represents a distinct species, mainly differing by its pubescence and by the (♂) flowers, which are twice as large as in *sylvestre*. *C. sylvestre* is a very uniform species.

13. **Canarium salomonense** Burtt, 1935, 302; Leenhouts, 1955a, 32, f. 14; 1956, 263, f. 21f.

Type: Solomon Islands, Bougainville, Sept. 1932, *Waterhouse Y73*, ♀ (K; isotypes in A, BISH).

Buttressed tree up to about 30 m by 30—50 cm, sometimes with stilt-roots. *Branchlets* ½—¾ cm thick, glabrescent; pith with several small vascular strands, partly peripherally arranged. *Stipules* subcaducous, inserted on the petiole at 4—15 mm from its base, auricle-shaped, 3—4 by 4—7 mm. *Leaves* 1—3-jugate. *Leaflets* elliptic to ovate, 6—14(—19) by 2.5—6.5(—10.5) cm, chartaceous to coriaceous, glabrous; base broadly cuneate to subcordate; margin entire; apex abruptly, short- and blunt-acuminate; nerves 8—14 pairs (angle c. 70°) straight to slightly curved, distinctly arching at some distance from the margin. *Inflorescences* terminal, short ferruginous-pubescent, glabrescent, ♂ ones laxly thyrsoid, 20—30 cm long, many-flowered, ♀ ones more slender, 8—20 cm long, less-flowered. *Flowers* tomentose outside, ♂ ones 4—5½ mm long, ♀ ones c. 1 cm with a slightly hollowed receptacle. *Calyx* in ♂ flowers 2 mm, in ♀ flowers 5½ mm. *Stamens* 6, glabrous, adnate to the disk. *Disk* glabrous, in ♂ flowers cylindrical, 6-lobed, 1 mm high, with a central canal, in ♀ flowers adnate to the receptacle, free rim 6-undulate, 1½ mm high. *Pistil* glabrous, in ♂ flowers none. *Infructescences* 10—12 cm long, with 1—4 fruits; calyx flat, faintly 3-lobed to orbicular, 1 cm diam. *Fruits* ellipsoid, 2.8—4.5 by

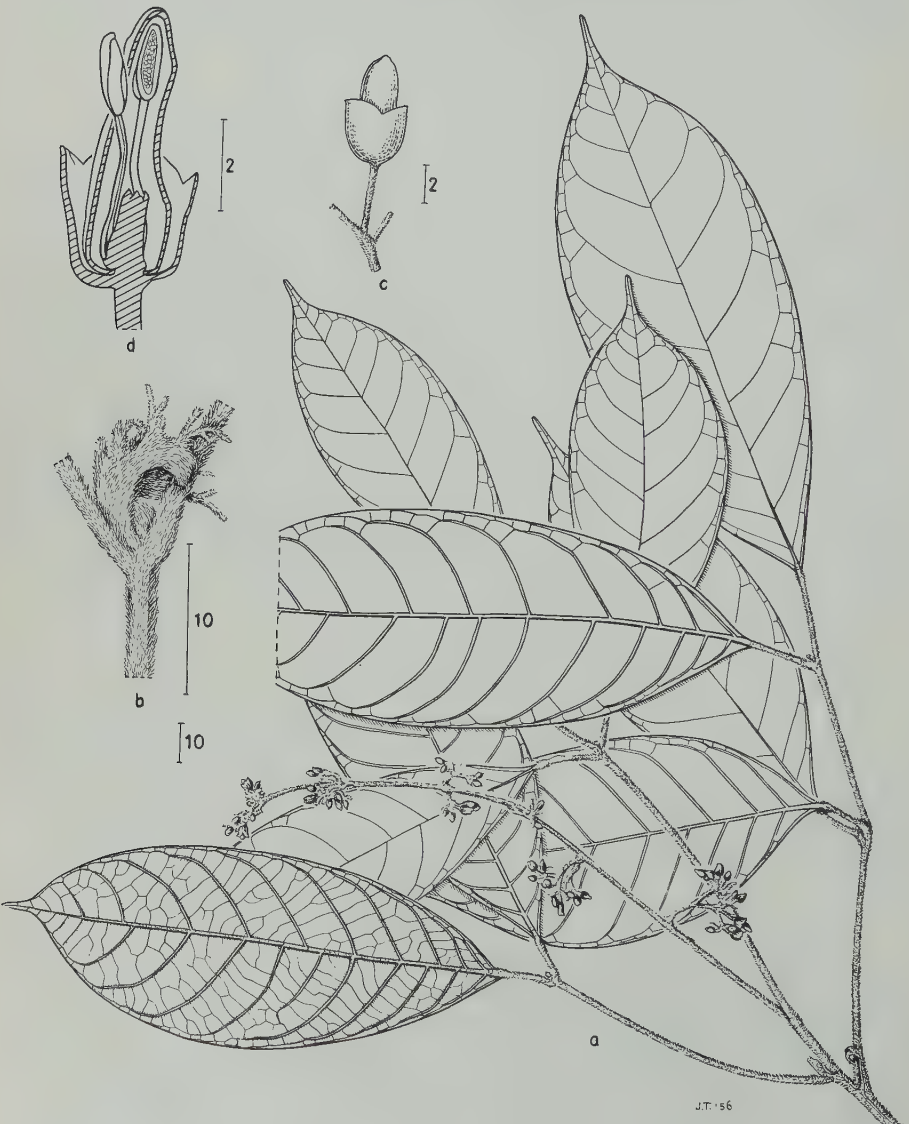


Fig. 16. *C. piloso-sylvestre* — a. twig with ⚦ inflorescence; b. stipules; c. ⚦ flower; d. ditto in section. (from *Aet 138*) (dimensions in mm).

1.8—2.7 by 1.4—2.5 cm, glabrous; pyrene smooth, pointed at the base and with 3 strong, blunt, white ribs at the apex; lids 3—5 mm thick. *Seed* 1; sterile cells strongly reduced.

Distribution: East New Guinea, Solomon Islands.

Taxonomy. Two subspecies can be distinguished:

A. Subsp. **salomonense.**

Leaves 1—2(—3)-jugate, the terminal leaflet not rarely obsolete. Stipules subpersistent. Leaflets (oblong-)elliptic to ovate, 6—14(—19) by 2.5—6.5(—10.5) cm; acumen up to 1.5 cm long. Fruits usually slightly flattened on one side; lids 2.5 mm thick.

Distribution: Solomon Islands, perhaps also on Woodlark Island (N. of D'Entrecasteaux Islands).

NEW GUINEA. Woodlark Island: *Brass 28740* (aff.).

SOLOMON ISLANDS. Bougainville: *Kajewski 1924, 2056; Waterhouse 73, Y73* (type), *B 545* (paratype), *B 725*. — New Georgia: *Waterhouse 86*. — Duke Island: *Waterhouse 296, 297*. — Guadalcanal: *Kajewski 2712*. — Florida: *BSIP. 363 (Silas-Rouse)*. — Malaita: *BSIP. 93 (Walker & White); Kajewski 2365*. — San Cristoval: *Brass 2847; Comins 112*.

Ecology: Rain-forests, up to c. 1000 m. *Fl.* June—Jan., *fr.* June—Oct.

Uses. Often cultivated, as the seeds are eaten by the natives; moreover, the resin is used for making torches.

B. Subsp. **papuanum** Leenhouts, 1955b, 188, f. 5f; 1956, 263, f. 21f.

Type: East New Guinea, Northern Div., foothills of Hydrographer's Range near new Inota village, alt. *c.* 125 m, Sept. 7, 1953, *Hoogland 3844*, fr. (L).

Leaves 3-jugate. Stipules rather caducous. Leaflets elliptic, 7—10 by 3—5 cm; acumen up to 3 mm long. Fruits more strongly flattened, rather small, 3.5 by 2.25 by 1.5 cm; lids up to 5 mm thick, very hard; sterile cells nearly totally reduced.

Distribution: East New Guinea.

NEW GUINEA. *Hoogland 3823* (paratype), *3844* (type), *3877* (paratype), *4831; NGF. 2099 (Cavanaugh & Fryar)* (paratype).

Ecology. Rain-forest up to 400 m alt., *fl. fr.* Sept.

Note. The present species is apparently related to *C. maluense*; the relatively broad, rather flattened pyrenes are characteristic.

14. Canarium harveyi Seemann, 1865, 35; Engler, 1883, 133; Hemsley, 1895, 171, 203, 210; Burkill, 1901, 31; Yuncker, 1943, 71; Leenhouts, 1955a, 35, f. 15, 16. — *C. sapidum* Hemsley, 1891, 504; Schumann und Lauterbach, 1901, 378; Lauterbach, 1920, 324. — *C. mafoa* Christophersen, 1935, 111, f. 14. — *C. sp. nov.* Guillaumin, 1931, 237, f. 2 B; 1948a, 28. — *C. vitiense* (*non* Gray) Degener, 1949, 294.

Type: Tonga Islands, Vavau and Lifuka, 1855, *Harvey s.n.*, fr. (K).

Tree up to *c.* 35 m high, rarely liana. *Branchlets* (4—)5—7(—9) mm thick, glabrescent; pith with some to many vascular strands, all or part of them peripherally arranged, central part of the pith sometimes vanishing. *Stipules* caducous, inserted on the petiole up to 1 cm from its base, auricle-shaped, 4—17 by 2—11 mm, shortly tomentose outside, coarsely reticulate-nerved. *Leaves* 2—3(—4)-jugate, minutely brown tomentose when young, glabrescent. *Leaflets* broad-ovate to elliptic or oblong, 4—20(—35) by 2—7.5(—13) cm, herbaceous to coriaceous; base oblique, broadly cuneate, rounded, truncate, or faintly cordate, slightly decurrent; margin entire; apex more or less gradually acuminate, acumen blunt; nerves (6—)8—13 (—17) pairs (angle 90—50°, decreasing from base to apex), straight to faintly curved, distinctly interarching near the margin; some intermediate veins well developed. *Inflorescences* axillary to pseudoterminal, minutely brown tomentose, glabrescent, ♂ ones thyrsoid, 10—20 cm long, with many flowers, ♀ racemose, 3.5—9 cm, with 6—7 flowers. *Flowers* tomentose, ♂ 4—6 mm, subsessile, ♀ 6 mm, with a slightly hollowed receptacle. *Calyx* in ♂ flowers 2.5 mm, in ♀ ones 3.5—4 mm. *Stamens* 6, free (in ♀ flowers sometimes confluent with the disk), glabrous. *Disk* in ♂ flowers rather variable, 0.7—1 mm high, fleshy, glabrous to shortly brown tomentose, with a central canal; in ♀ flowers adnate to the receptacle with the exception of the faintly 6-lobed rim, glabrous. *Pistil* glabrous, in ♂ flowers absent. *Infructescences* 2—12 cm long, with 1—4 fruits; calyx flat, faintly 3-lobed, 6—8 mm in diam. *Fruits* extremely variable (see varieties), glabrous. *Seeds* usually 1(—2); sterile cells usually strongly to nearly entirely reduced.

Distribution: Solomon Islands, New Hebrides, Tonga-, Fiji-, and Samoa Islands.

Taxonomy. The present species is rather variable, especially in its fruit-characters, which apparently characterize the local populations of the different groups of islands. Therefore, even though the material at hand is still very insufficient, I propose the following provisional subdivision into 4 varieties:

a. var. **sapidum** (Hemsley) Leenhouts, 1955a, 37, f. 15d, g, k. — *C. sapidum* Hemsley.

Type: Solomon Islands, San Cristoval, Oct. 1890, *Comins 224*, ♀ and fr., lectotype (K).

Main characteristics: Part of leaves large, probably more than 40 cm long; their leaflets very large, up to 23—35 by 7—13 cm, apex abruptly and long and bluntly acuminate, acumen 1.7—3.3 by 0.5—0.6 cm; secondary nerves 10—17 pairs. Petals of female flowers tomentose at both sides. Fruits elliptic, 5 by 2.5 by 2.5 cm; pyrene faintly 6-angular, at base acutely 3-angular, smooth; lids 2—3.5 mm thick; 3-celled, 2 cells slightly reduced.

Distribution: Solomon Islands, Santa Cruz group excepted.

SOLOMON ISLANDS. Shortland Island: *Guppy 320*. — Treasury Island: *Guppy 305* (paratype), *319* (paratype). — Oima Atoll: *Guppy 318* (paratype). — San Cristoval: *Comins 224* (type).

Ecology: *Fl.* Oct., *fr.* Aug., Oct. The nuts are eaten by pigeons.

b. var. **nova-hebridiense** Leenhouts, 1955a, 37, f. 15j, l, 16c. — *C. sp. nov.* Guillaumin.

Type: New Hebrides, Banks Islands, Vanua Lava, sea level, July 5, 1928, *Kajewski 408*, fr. (BISH; isotypes in A, K, P).

This variety is mainly characterized by its fruits, being obovoid, flattened at one side, with 2 lateral acute ribs, 2 ribs at the flattened side and a median one at the convex side, 5 by 3.2 by 2.3 cm, pyrene smooth, but for the 5 ribs; lids 2.5—3 mm thick; 3-celled, 2 cells strongly to almost entirely reduced.

Distribution: Solomon Islands (Santa Cruz) and New Hebrides (Banks Islands).

SOLOMON ISLANDS. Santa Cruz: *Kajewski 548* (paratype).
NEW HEBRIDES. Banks Islands: *Kajewski 408* (type).

Ecology: Rain-forest at sea-level. *Fr.* July, Nov.

c. var. **harveyi**; Leenhouts, 1955a, 38, f. 15a—c, e, f, h, n. — *C. harveyi* Seem. — *C. mafoa* Christophersen.

The main differences between this variety and the others are found in the fruits, which are relatively small, 3—4 by 2.4—2.8 by 1.7—1.9 cm, obovoid, 3-celled, 2 cells entirely or almost entirely reduced; pyrene smooth, but for 3 acute ribs. In nearly all other characteristics this variety is almost as variable as the species as a whole.

Distribution: Tonga-, Fiji-, and Samoa Islands, Niue.

TONGA ISLANDS. Vavau: *Crosby 213; Harvey s.n.* (type). — Eua: *Parks 16171, 16349.*
FIJI ISLANDS. Viti Levu: *Gillespie 3620, 3658; Smith 9314.* — Ngau: *Smith 7767.* — Vanua Mbalavu: *Smith 1506.* — Fulanga: *Smith 1151.*
SAMOA ISLANDS. Savaii: *Christophersen 2582, 3369* (paratype *C. mafoa* Christ.), *3373* (type *C. mafoa* Christ.). — Tutuila: *Swezey & Wilder 256.*
NIUE. *Yuncker 9849.*

Ecology: Forests, from sea-level up to *c.* 600 m. *Fl.* Sept.—Febr., *fr.* June—Dec.

d. var. **scandens** Leenhouts, 1955a, 39, f. 15m, p—r, 16a, b, d. — *C. vitiense* (*non* A. Gray) Degener.

Type: Fiji Islands, Viti Levu, Vatutavathe, alt. 150 m, May 5, 1941, *Degener 15196*, fr. (A; isotypes in BISH, K, NY).

The main differences between this and all other varieties are the following: Liana. Branchlets more slender (4.5 mm thick). Leaves relatively small in all parts; total length 12—28 cm. Leaflets 4—11 by 2—6 cm, coriaceous, grey-green when dry. Fruits extremely variable, more or less broadly ovoid, usually flattened on one side, 3.2—4 by 2—2.5 by 1.4—2.5 cm; pyrene smooth, with or without three acute ribs, or strongly rugose; lids 3—6 mm thick; 3-celled, (1—)2 cells very strongly or entirely reduced, sometimes (in sterile fruits, *Degener 15196*) situated close to pericarp.

Distribution: Fiji Islands (Viti Levu).

FIJI ISLANDS. Viti Levu: *Degener 15159* (paratype), *15196* (type); *Gillespie 2320* (paratype).

Ecology: Forests up to 400 m. *Fr.* May, Aug.

Uses. The nuts are eaten by both natives and Europeans in the Solomons and New Hebrides, and the resin is used as a perfume in Samoa.

15. **Canarium vulgare** Leenhouts, 1955a, 31, f. 13; 1955b, 188; 1956, 263, f. 19, 22g & 26—30. — *C. vulgare tertia et quarta species* Rumphius, 1741, 146, t. 47 F—I; Lotsy, 1902, t. opp. p. 46. — *C. commune* Linné, 1767, 127, *pro min. part. typo excl.*; Blume, 1826, 1161, *p. p.*; Roemer & Schultes, 1830, 1622; Blume, 1850, 214, *incl.* also *var. minor*; Miquel, 1859, 643; Bennett, 1875a, 531; 1875b, 102; Engler, 1883, 112, t. 2 f. 35—39; King, 1894b, 246; Engler & Prantl, 1896, f. 136 A—E; 1931, f. 211 A—E; Koorders & Valeton, 1896, 35; Backer, 1907, 264; 1911, 198; Koorders, 1912, 433; Koorders & Valeton, 1913, t. 149; Heyne, 1927, 873; Petch, 1930, 279, t. 35 & 36; Lam, 1932a, f. 51, t. 15, f. 124; 1932b, 509; Funke, 1932, 38—39; Went, 1932, 41; Van Heurn & Lam, 1937, 97; Van Steenis, 1938, 54; Corner, 1940, 178, t. 38; Lam, 1948, 5; Van Steenis, 1951, 232.

Type: Lesser Sunda Islands, Bali, Tjandikusuma, alt. 20 m, April, 1920, *Becking 142,* fr. (L; isotype in BO).

Tree up to 45 m by 70 cm; buttresses up to 3 m high and 1½ m wide. *Branchlets* c. ½ cm thick, smooth, glabrous; pith with many vascular strands, partly peripherally arranged. *Stipules* rather caducous, inserted at the conjunction of the petiole and the branchlet, rarely entirely on the base of the petiole, oblong, 1—5 by ½—1¾ cm, apex rounded, margin entire, glabrous to slightly pulverulent. *Leaves* (2—)4—5-jugate, glabrous. *Leaflets* ovate to oblong, 5—16 by 2½—7(—10) cm, chartaceous to subcoriaceous; base often slightly oblique, (broadly) cuneate; margin entire; apex gradually to subabruptly, rather long and slender-acuminate; nerves 12—15 pairs (angle 60—70°), straight to faintly curved, gradually arching at some distance from the margin. *Inflorescences* terminal (basal branches often axillary), broadly thyrsoid, minutely pulverulent, ♂ ones up to 35 cm long, main branches up to 20 cm, ♀ ones up to 20 cm long, main branches up to 10 cm. *Bracts* concave. *Flowers* tomentose, ♂ (sub)sessile, 5 mm long, ♀ stalked, 6—7(—12) mm, often with a concave receptacle. *Stamens* free, glabrous. *Disk* glabrous, in ♂ flowers solid, rather variable in size and shape, sometimes with a style-like appendix; in ♀ flowers adnate to the receptacle but for the rim. *Ovary* glabrous, in ♂ flowers none. *Infructescences* broadly thyrsoid, up to *c.* 15 cm long, with up to *c.* 12 fruits; calyx flat, orbicular with undulate margin, 7—13 mm diam. *Fruits* ovoid, round to slightly trigonous in cross-section, 3½—5 by 1½—3 cm, glabrous; pyrene smooth with 3 blunt, white ribs near the base; lids *c.* 4 mm thick. *Seeds* 3—1; sterile cells not strongly reduced.

Distribution: Kangean & Bawean Islands (near East Java), Lesser Sunda Islands (Flores, Timor, Wetar, Tanimbar), Celebes, Moluccas (Talaud, Morotai, Sula, Ceram, Banda, Aru).

Perhaps naturalized in some other parts of Malaysia, cultivated in tropical regions all over the world.

JAVA. Kangean Islands: *Backer 27830, 27954, 29608; Dames 22.* — Bawean: *Karta 1.*

LESSER SUNDA ISLANDS. Flores: *FRI. bb. 9638.* — Alor: *Jaag 527.* — Timor: *Van Steenis 18204.* — Wetar: *FRI. bb. 27244.* — Tanimbar: *Buwalda 4476; FRI. bb. 24355.*

CELEBES. *Docters van Leeuwen 1551; Forsten 438; FRI. bb. 15050, bb. 24114, bb. 32752 (Rorongpandey 2).*

MOLUCCAS. Talaud: *Lam 3131.* — Morotai: *FRI. bb. 24571, bb. 33753*

(Tangkilisan 45), bb. 33852 (Tangkilisan 165), bb. 33859 (Tangkilisan 172), bb. 33863 (Tangkilisan 177), bb. 33917 (Tangkilisan 247); Lam 3457. — Sula: *FRI. bb. 29787.* — Ceram: *FRI. bb. 23043.* — Bandanera: *Lauterbach 3038.* — Aru: *Beccari herb. 2166, 2169; FRI. bb. 25484.*

cultivated:

Backer 22; Bakhuizen v. d. Brink Jr. 1582; Bakker Jr. 20; Becking 142 (type) (most probably wild); *Blume 667; Britton, N. L. & E. G., 9326; BS 29255 (Wester), 85684 (Quisumbing); Cantley's coll. 2681; Chevalier 31334; Clemens, J. & M. S., 22427; Commerson 592; Dorgelo 1708; Evrard 2374; Fairchild 3702; Forbes 6, 1208; Gibbons 1026; Greenway 2884; Henderson 1360; Herb. d'Alleizette 1161; Hook(er?) 837; Hort. Bot. Bogor 42, 51, VI B 66, XII B IX 128; Hort. Bot. Pamplemousses 108, 150; Hullett 137; Jack 4199, 4790; Junghuhn in herb. U 32921; Kanehira 848; Karta 198; Kehding 1014; Koorders 917β, 975β; Kostermans 11087; Kuntze 5086, 5086 A; Lahaie 153, 193; Lam 2297; Lindeman 4486; Long 176; MacDaniels 413; Macrae 332; Nur 195; Parham 1540; PNH. 380 (Gonzalez), 394 (Quisumbing); Popta 00603/198 A, B, C; Proefstation voor de Java Suikerindustrie te Pasoeroean 305a, 315b; Ridley 6895; Rock 17140; SF. 4161 (Burkill), 34847 (Furtado); Volkens 35; De Voogd 667; De Vriese 45; Wallich 8493 D; Warburg 2059; Wawra 1247; Wetmore & Abbe 286; Wight 387; Wilder 462, 860; Zollinger 2994.*

Ecology: Mainly in primary forests on limestone, sometimes, locally gregarious, *fl.* mainly March—June (Java: Aug.—Dec.), *fr.* mainly April—May.

Wood anat.: Den Berger, Med. Proefst. Thee 97 (1926) 66 & Atlas pl. 11 fig. 44, Med. Proefst. Boschw. 13 (1926) 66 & Atlas ditto (*C. commune* L.) (hand lens); Moll & Janssonius, Mikr. Holzes 2 (1908) 108 (*C. commune* L.).

Uses. Planted as a shade-tree in nutmegplantations and as a roadside tree. The timber is rather soft and mainly used as firewood; in Bawean and Kangean it is also used for canoe-building; sometimes paddles are made out of the buttresses. The resin is not abundant and without importance. The seeds are highly estimated as a titbit, and are sometimes used as a substitute for almonds; the oil from the seeds is used as a substitute of coconut-oil. An emulsion of the seeds can be of importance as a baby-food (Heyne, *l. c.*). For an analysis of the seed-oil see Steger & Van Loon, Rec. Trav. Chim. Pays-Bas 59 (1940) 168.

Note. Closely related to *C. indicum* and for a long time not distinguished as a separate species; in consequence the synonymy of these two species is very complicated (see Leenhouts, 1955a, *l. c.*). Distinguishable from the last-named species by being more slender in all parts, and by its more or less caducous, entire stipules.

16. Canarium indicum Linné, 1759. 143; Leenhouts, 1955a, 26, f. 12; 1956, 266, f. 21g & 31—34. — *C. vulgare prima et secunda species* Rumphius, 1741, 145, t. 47 A—E. — *C. zephyrinum* Rumphius, 1741, 151, t. 48; Duchesne, 1836, 289; Blume, 1850, 217; Miquel, 1859, 643; *non* Fernandez-Villar, 1880, 40 (= *C. ovatum* Engl.); Engler, 1883, 149; Merrill, 1917, 304; Heyne, 1927, 879. — *C. commune* Linné, 1767, 127, *pro maj. part.*, *typo incl.*; 1774, 741; Lamarck, 1783, 598; Linné, 1784, 885; 1797, 928; König, 1805, 360; Willdenow, 1805, 759, *incl.* also *var. β*; De Candolle, 1825, 79, *incl.* also *var. zephyrinum*; Roemer & Schultes, 1829, 78, *non* 1830, 1622 (= *C. vulgare* Leenh.); *non* Blanco, 1837, 791 (= *C. asperum* Benth.); *non* Fernandez-Villar, 1880, 40 (= *C. luzonicum* A. Gray);

Merrill, 1917, 301; *see also under C. vulgare* Leenh. — *C. mehenbethene* Gaertner, 1791, 98, t. 102, *nom. illeg.*; Miquel, 1859, 643; Engler, 1883, 149; 1896, f. 136 F—H; 1931, f. 211 F—H; Guillaumin, 1909a, f. 12—13; Lam, 1931—32, t. 5 f. 13—14, t. 15 f. 122a; 1932b, 515; Van Heurn & Lam, 1937, 97; White, 1950, 91. — *C. moluccanum* Blume, 1850, 216, *incl.* also *var. obtusatum*; Koorders & Valeton, 1896, 33, 313; 1897, t. 9; Guillaumin, 1909a, f. 22^1, f. 28; Backer, 1911, 197; Koorders, 1912, 433; Lauterbach, 1920, 320, *incl.* also *var. palla* and *f. porphyropyrena*; Heyne, 1927, 873. — *C. subtruncatum* Engler, 1883, 109. — *C. amboinense* Hochreutiner, 1904, 55; 1905, 5; Guillaumin, 1909a, f. 22^{20}; Hochreutiner, 1910, 841; Heyne, 1927, 873. — *C. shortlandicum* Rechinger, 1912, 184. — *C. polyphyllum* (*non* K. Sch.) Krause, 1913, 147. — *C. grandistipulatum* Lauterbach, 1920, 321; Lane-Poole, 1925, 189. — *C. nungi* Guillaumin, 1931, 236.

Type: Moluccas, *Hort. Bot. Bog. VI B 65,* ♀, neotype (L; isotypes in BR, BRSL, G, K, L, NY, P, U).

Tree up to 40 by 1 m, with buttresses. *Branchlets* 7—13(—25) mm thick, glabrescent; pith with a peripheral cylinder of small vascular strands close to the inner side of the wood, central part with a second cylinder or some dispersed strands. *Stipules* persistent, inserted at the conjunction of branchlet and petiole (orbicular to) ovate to oblong, 1½—12 by 1¼—14 cm, striate to reticulate, pulverulent to glabrous, often slightly cordate at base, margin coarsely to minutely fimbriate-dentate to undulating. *Leaves* 3—8-jugate, glabrous. *Petiolules* rather long (¾—3 cm) and slender. *Leaflets* oblong-obovate to oblong-lanceolate, (5½—)7—35 by (2—)3½—16 cm, herbaceous to coriaceous; base oblique, rounded to broadly cuneate; margin entire; apex gradually to subabruptly, bluntly acuminate; nerves (8—)10—15 (—20) pairs (angle 85—55°, decreasing from base to apex), straight to faintly curved, faintly or not arching near the margin. *Inflorescences* terminal, broadly thyrsoid, 15—40 cm long, minutely tomentose, rather many-flowered; bracts concave, dentate at the apex, caducous. *Flowers* tomentose, ♂ ones subsessile, *c.* 1 cm long, ♀ ones shortly stalked, up to 1½ cm long, with a concave receptacle. *Calyx* in ♂ flowers 5—7 mm long, in ♀ ones 7—10 mm. *Stamens* glabrous, in ♂ flowers free, in ♀ flowers adnate to the disk. *Disk* in ♂ flowers cushion-shaped, 1 mm high, glabrous, in ♀ flowers adnate to the receptacle except the minutely pilose margin. *Pistil* in ♂ flowers minute to none, in ♀ glabrous. *Infructescences* large, with up to *c.* 30 fruits; calyx flat, orbicular, margin often ruptured, 1¾—2½ cm diam. *Fruits* ovoid, round to slightly triangular in cross-section, 3½—6 by (1½—)2—4 cm, glabrous; pyrene rounded triangular in cross-section, smooth except the 3 more or less acute ribs at base and apex; lids 3—4 mm thick. *Seeds* usually 1; sterile cells slightly reduced.

Distribution: North Celebes (very probably naturalized), Moluccas (Ternate, Sula, Ceram, Ambon, Kai), New Guinea, New Britain, New Ireland, Solomon Islands, and New Hebrides.

Taxonomy. The following two varieties can be distinguished:

a. var. **indicum**. — All synonyms.

Branchlets up to 13 mm thick. Stipules up to 6 by 4 cm, dentate.

Leaves up to 7-jugate. Leaflets up to 28 by 11 cm, herbaceous to coriaceous. Fruits up to 6 by 3 cm.

Distribution: as the species.

Celebes. *FRI. bb. 32448 (Panambunan 1).*

Moluccas. *Hort. Bot. Bogor VI B 65* (neotype). — Ternate: *Beguin 662, 1002, 1003.* — Sula: *FRI. bb. 28817.* — Ceram: *Buwalda 5609; FRI. bb. 25899.* — Ambon: *Beccari herb. 2164; Boerlage 82; Dolleschal 261* (syntype *C. subtruncatum* Engl.); *Hort. Bot. Bogor VI B 83, VI B 88* (type *C. amboinense* Hochr.); *Lahaie 862; Robinson Pl. Rumph. Amb. 380, Pl. Rumph. Amb. 381; d'Urville 468; Warburg 17395.* — Kai: *Beccari herb. 2163.*

New Guinea. *BW. 1512 (Schram), 1609 (Brouwer), 1693 (Schram), 2667 (Schram), 2735 (Schram); Docters van Leeuwen 11280; FRI. bb. 22557, bb. 32688 (Lundquist 69); Gjellerup 730; Hoogland 5036; Kanehira 3973; Lane Poole 338; Ledermann 8073* (syntype *C. grandistipulatum* Lauterb.), *10599* (syntype *C. grandistipulatum* Lauterb.); *NGF. 1819 (Mair), 2775 (Schacht); Warburg 20158; Waterhouse 407, 411, 412.* — New Britain: *Lauterbach 301; NGF. 3428 (Womersley), 3466 (Floyd), 7089 (Womersley & Kazakoff); Waterhouse 316, 405, 406, 882, 950, 951, 964.* — New Ireland: *Peekel 386* (type *C. moluccanum* Blume *var. palla* Lauterb.), *399* (type *C. moluccanum* Blume *f. porphyropyrena* Lauterb.), *555.*

Solomon Islands. Bougainville: *Kajewski 1828; Waterhouse 69, 70, 106.* — Shortland Islands: *Rechinger, K. & L., 4900* (type *C. shortlandicum* Rechinger). — New Georgia: *BSIP. 3A (Walker); Waterhouse 110, 220, 298, 299; White 93A.* — Isabel: *Brass 3468.* — Guadalcanal: *BSIP. 3 (Walker).* — San Cristoval: *Brass 2631, 2701.*

New Hebrides. *Barrau NH 3, NH 22; Kajewski 122* (syntype *C. nungi* Guillaumin), *243* (syntype *C. nungi* Guillaumin).

cultivated:

Dept. of Agriculture Rabaul VB 1, VB 2, VB 3; Eames 197; Forbes 7; Greenway 2885; Hort. Bot. Bogor VI B 30, VI B 65a, VI D 10; Kanehira 739; Lam 3831, 6943; Marche 192; Moore 773.

locality unknown:

Van de Koppel 4140; De Vriese in herb. L 898.319—372 (type *C. subtruncatum* Engl.).

Ecology: Rain-forests at low altitude, rarely up to c. 250 m; planted up to 600 m or more. *Fl.* mainly Oct.—Dec., *fr.* mainly July—Dec.

Wood anat.: Webber, Lilloa 6 (1941) 450 (*C. mehenbethene* Gaertn.).

Uses. Mainly the same as in *C. vulgare*, though of less importance. In Melanesia the seeds apparently are highly estimated as a food and several races are cultivated, mainly varying in the form and size of the fruits.

b. var. **platycerioideum** Leenhouts, 1955b, 182; 1956, 269.

Type: West New Guinea, Vogelkop, Tisa near Steenkool, alt. 3 m, May 9, 1941, *FRI. bb. 32637 (Lundquist 18)*, st. (BO; isotype in L).

Very coarse. Branchlets up to 2½ cm thick. Stipules sometimes inserted on the base of the petiole only, orbicular to obovate, 4—12 by 4—14 cm, subcoriaceous, glabrous, margin undulating, nervation lax, anastomosing (stipules resembling the basal leaves of *Platycerium*). Leaves 5—8 (or more?)-jugate, 80—135 cm long. Leaflets inequilateral, ovate, 25—35 by 13—16 cm. Flowers unknown. Fruits 6 by 3½—4 cm.

Distribution: N.W. New Guinea (Vogelkop).

New Guinea. *Beccari PP 568* (paratype); *BW. 1928 (Schram), 1932 (Schram)* (aff.), *2545 (Brouwer)* (paratype), *4508 (Lasschuit); FRI. bb. 32637 (Lundquist 18)* (type), *bb. 32949 (Lundquist 230)* (aff.), *bb. 33446 (Kostermans 242)* (aff.); *Kostermans 77, 265, 2736* (aff.).

Ecology: Collected only at altitudes up to 30 m.

Note. Closely related to and for a long time confused with *C. vulgare,* moreover related to *C. kaniense.* For an account of the complicated nomenclature see Leenhouts, 1955, *l. c.*

17. **Canarium kaniense** Lauterbach, 1920, 322; Lam, 1932a, t. 15 f. 121; 1932b, 515, t. 13 f. 88; Leenhouts, 1956, 269, f. 1 a—h. — *C. gawadaense* Baker, 1923, 7; Lam, 1932a, t. 13 f. 104n; 1932b, 527, t. 14 f. 91.

Type: N.E. New Guinea, Kani Mts, alt. 1000 m. Dec. 25, 1907, *Schlechter 17051,* ♂ (BRSL; isotype in P).

Tree up to 40 m by 75 cm, sometimes with buttresses. *Branchlets* ½—1 cm thick, glabrescent; pith with one or two concentric cylinders of vascular strands. *Stipules* subpersistent, inserted either on the branchlet or on the petiole, elliptic to obovate, 1—8 by ½—4 cm, subcoriaceous, minutely pubescent to glabrous, margin repeatedly and more or less deeply dentate to fimbriate, nervation coarse, anastomosing. *Leaves* 3—5(—6)-jugate, glabrous. *Leaflets* ovate to oblong, 8—25 by 3½—9 cm, chartaceous to subcoriaceous; base slightly oblique, broadly cuneate to rounded; margin entire; apex gradually to abruptly, shortly to rather long, blunt-acuminate; nerves 9—18 pairs (angle 50—80°), straight to faintly curved, sometimes arching near the margin. *Inflorescences* (♀ unknown) terminal and in the upper leaf-axils, narrowly thyrsoid, *c.* 30 cm long, densely tomentose, main branches up to *c.* 9 cm; flowers in glomerules; bracts like the stipules, though smaller and less deeply fimbriate. *Flowers* (♀ unknown) subsessile, 7 mm long, pubescent. *Calyx* 5 mm. *Stamens* glabrous, slightly adnate to the disk. *Disk* annular, 1—2 mm high, thinly pilose. *Pistil* columnar, 1½ mm high, glabrous. *Infructescens* terminal, narrowly thyrsoid, 25—30 cm long, thinly pilose, with 5—6 fruits; calyx flat, orbicular, 1½—2 cm diam., with remnants of an annular disk and of free stamens. *Fruits* see under varieties. *Seeds* 1(—2); sterile cells slightly reduced.

Distribution: East New Guinea.

Taxonomy. The following two varieties are distinguishable.

a. var. **kaniense.** — All synonyms.

Stipules 1—3 by 0.5—2 cm, the margin dentate to slightly fimbriate only. Leaves 3—5(—6)-jugate. Leaflets ovate to elliptic, 8—12 by 3½—7 cm; acumen up to 15 by 3 mm; nerves 9—15 pairs. Fruits ovoid, deltoid in cross-section, 5—6 by 3—4 cm, glabrous; pericarp fleshy; pyrene smooth, triangular, with hollow sides, sometimes with acute angle-ribs and/or faint median ribs; lids 2—5 mm thick.

Distribution: As the species.

NEW GUINEA. *Clemens 7953; Forbes 519* (type *C. gawadaense* Baker); *Lauterbach 1554, 1571; NGF. 1285 (Smith); Schlechter 17051* (type).

Ecology: In forests at (25—)1000—2000 m alt., *fl.* Dec., *fr.* Jan.—March.

Uses. The oily seeds are eaten.

b. var. **globigerum** Leenhouts, 1955b, 182; 1956, 270, f. 21a—c, 22h.

Type: East New Guinea, Northern Div., 3 km North of Divinikoari village, alt. 30 m, Aug. 23, 1953, *Hoogland 3727*, fr. (L; isotype in CANB.).

Stipules 3½—8 by 2—4 cm, the dentate margin densely fimbriate, segments subulate and branched, up to 2 cm. Leaves 4—6-jugate. Leaflets ovate to oblong, mostly 15—25 by 9 cm; abruptly caudate-acuminate, acumen up to 30 by 1 mm; nerves 12—18 pairs. Fruits globular, c. 5 cm diam.; epicarp egg-shell-like, pericarp somewhat fibrous; pyrene acutely 3-winged, specially in the lower half, lids slightly concave with a faint median rib; lids 1½ mm thick.

Distribution: like var. *kaniense*.

New Guinea. *Clemens 1288; Hoogland 3727* (type); *NGF. W. 330.*

Ecology: like var. *kaniense*.

Notes: Sharply defined only by its fruit-characters. As both varieties are very insufficiently known, their status is still uncertain.

Related to *C. indicum*; it differs by its stipules and fruits.

18. Canarium luzonicum (Bl.) A. Gray, 1854, 374; Miquel, 1859, 651; Engler, 1883, 150; Merrill, 1905a, 30; 1905b, 53; Guillaumin, 1908c, 616, t. 19 f. 2; Merrill, 1908a, 80; Whitford, 1911, 56; Merrill, 1918a, 207; Brown, 1921, 40, 300, f. 11; Merrill, 1923, 351; Lam, 1932a, t. 11 f. 56; 1932b, 532; Burkill, 1935, 430; Manalo & West, 1950, 111; Quisumbing, 1951, 475; Leenhouts, 1956, 270. — *C. album* (*non* DC.) Blanco, 1837, 793; 1845, 546; 1879, 201; Merrill, 1905a, 30. — *Pimela luzonica* Blume, 1850, 220. — *C. commune* (*non* L.) Fernandez-Villar, 1880, 40. — *C. triandrum* Engler, 1883, 145, t. 3 f. 19—22; Jadin, 1894, t. 15 f. 9 A. — *C. polyanthum* Perkins, 1904, 95. — *C. carapifolium* Perkins, 1904, 91. — *C. oliganthum* Merrill, 1915a, 23; Lam, 1932b, 534.

Type: Philippines, Luzon, Rizal Prov., San Mateo, Jan. 1915, *Merrill Sp. Blanc. 713*, fr., neotype (L; isotypes in A, BM, K, L, NY, P, W).

Tree up to 35 m by 1 m or more. *Branchlets* 4—6(—8) mm thick, glabrescent, lenticellate; pith with many peripherally arranged vascular strands. *Stipules* caducous to subpersistent, inserted on the base of the petiole (up to 5 mm from the branchlet), orbicular, c. 8 mm diam., pubescent. *Leaves* 3—5-jugate, glabrous. *Leaflets* lanceolate to oblong, 6½—25 by 3½—8½ cm, subcoriaceous; base equilateral, broadly cuneate to cordate; margin entire; apex gradually, long and broadly, blunt acuminate; nerves 14—18 pairs (angle *c.* 65°), straight to slightly curved, gradually to subabruptly arching at some distance from the margin. *Inflorescences* axillary, together pseudoterminal, thyrsoid, glabrescent, ♂ ones 10—25 cm long, ♀ ones 5—18 cm; main branches up to 4½ cm long, in ♂ ones many-flowered, in ♀ ones 3—5-flowered. *Flowers* subsessile, pubescent, ♂ 2½—4 mm long; ♀ 6—8 mm, with a concave receptacle. *Calyx* ♂ 1½ mm high, ♀ 5 mm. *Stamens* glabrous, ♂ 6—3, free, ♀ 6, slightly connate at the base. *Disk* ♂ cushion-shaped, flat, solid, ⅓ mm high, densely tomentose; ♀ adnate to the receptacle, with a free rim, glabrous. *Pistil* ♂ none, ♀ pilose. *Infructescences* 4—10 cm long, glabrous, with 1—4 fruits; calyx flat, bluntly triangular, 10—12 mm diam. *Fruits* shortly ovoid to ellipsoid, round to bluntly triangular in cross-section, 2½—3¾ by 1½—2 cm, glabrous; pyrene smooth; lids *c.* 2½ mm thick. *Seeds* 1(—2); sterile cells small.

Distribution: Philippines (Mindoro, Luzon, Alabat Isl., Masbate, Ticao Isl., Bohol).

PHILIPPINES. Mindoro: *FB. 4062 (Merritt); PNH. 19180 (Conklin 723).* — Luzon: *Ahern 63* (syntype *C. carapifolium* Perkins); *Ahern's coll. Dec. Philipp. For. Flora 160; BS. 22482 (Ramos & Deroy); Callery 63 bis, s.n.* (type *C. triandrum* Engl.); *Elmer 17803, 18207; FB. 1753 (Borden), 1990 (Ahern's coll.), 3271 (Ahern's coll.), 9623 (Zschokke), 12924 (Alvarez), 13140 (Bernardo), 15371 (Tamesis), 17511 (Curran), 23626 (Paraiso), 24213 (Barros), 30208 (Rabaya), 30209 (Rabaya), 30210 (Rabaya), 31261 (Paraiso)!; Loher 5859; Merrill 1894, 1898, 2010, 2610, 2624, Species Blancoanae 713* (neotype); *Vidal 696, 697, 698, 1342, 1345, 2292; Whitford 682, 856, 857, 879.* — Alabat Isl.: *BS. 47982 (Ramos & Edaño).* — Masbate: *FB. 2539 (Clark); Merrill 2615, 2618* (type *C. oliganthum* Merrill). — Ticao Isl.: *FB. 1070 (Clark); Vidal 2296.* — Bohol: *BS. 42649 (Ramos).*

Ecology: Common in primary forests at low and medium altitudes. *Fl.* (Apr.—) Aug.—Sept. (—Oct.), *fr.* (Aug.—) Jan.—Febr. (—May).

Wood anat.: Reyes, Dep. Agr. & Comm. Manila, Techn. Bull. 7 (1938) 161 (hand lens).

Uses. The timber, which is not very hard, is sometimes used. This tree is the principal source of *manila-elemi* (see Brown, *op. cit.* 40; Valenzuela *et al.*, Philip. J. For. 6, 1949, 54; Manalo & West, *l. c.*; Guenther, The essential oils, 4, 1950, 357; Quisumbing, *l. c.*). The seeds are eaten as *pili nuts,* though the main source of these is *C. ovatum.*

Note. This species is related to *C. vulgare* as well as to *C. ovatum.* The former does not occur in a wild state in the Philippines and is even rarely cultivated. The main differences between *C. luzonicum* and *C. ovatum* are: stipules orbicular, very caducous, and leaves rather thin in the former species, stipules persistent, acute, and stiff, and leaves stiff-coriaceous in the latter one. Moreover, the fruits of *C. ovatum* are usually much larger than those of *C. luzonicum.*

19. Canarium ovatum Engler, 1883, 110; Brown, 1921, 114, 300, f. 40; Merrill, 1923, 352; Lam, 1932a, t. 12 f. 88, t. 15 f. 120b; 1932b, 533; Burkill, 1935, 431; Quisumbing, 1951, 476, 1036; Leenhouts, 1956, 271, f. 22 f. — *C. pachyphyllum* Perkins, 1904, 94. — *C. melioides* Elmer, 1911, 1079; Merrill, 1923, 351.

Type: Philippines, Luzon, Albany Prov., 1841, *Cuming 904,* ♂ (W; isotypes in BM, G, K, MEL, NY, P).

Tree up to 20 m by 50 cm. *Branchlets* 6—12 mm thick, glabrous, lenticellate; pith with many small vascular strands appressed to the wood. *Stipules* persistent, inserted on the petiole up to 6 mm from its base, deltoid to lingulate, 5—20 by 3—10 mm, acute, stiff-chartaceous, glabrescent. *Leaves* 2—4-jugate, glabrous. *Leaflets* ovate to elliptic, 4—24 by 2—12 cm, stiff-coriaceous; base oblique, (cuneate to) rounded to subcordate; margin entire; apex (rather) abruptly acuminate, acumen cuneate to long and slender, blunt; nerves 8—12 pairs (angle 60—90°), straight to faintly curved, rather abruptly or gradually arching at some distance from the margin. *Inflorescences* axillary, close together at the ends of the branches, narrowly thyrsoid to nearly racemose, 3—12 cm long, glabrescent, few-flowered; main branches decussate, up to 2½ cm, with up to 5 flowers. *Bracts* concave. *Flowers* (sub)sessile, pubescent, up to 12 mm long, ♀ ones with a slightly concave receptacle. *Calyx* ♂ 7 mm high; ♀ 8—9 mm. *Stamens* 6, glabrous, ♂

slightly adnate to the disk, ♀ inserted on the rim of the disk. *Disk* ♂ cylindrical, 3—3½ mm high, solid, densely tomentose, rim 6-lobed; ♀ adnate to the receptacle, with 6-lobed rim, glabrous. *Pistil* ♂ none, ♀ glabrous. *Infructescences* 3—9 cm long, with 1(—2) fruit(s); calyx flat, orbicular, 1¾—2 cm diam. *Fruits* ovoid to ellipsoid, acute, triangular in cross-section, 3½—6¼ by 2—2¾ cm, glabrous; pyrene triangular in cross-section, the sides slightly furrowed, angle-ribs rounded except at the acute base and apex; lids 1½—2 mm thick. *Seed* 1; sterile cells strongly reduced.

Distribution: Philippines (S. Luzon, Polillo, Samar, Leyte, Mindanao). Sometimes cultivated, also in other parts of Malaysia and in Micronesia and Melanesia.

PHILIPPINES. Luzon: *Britton 79; BS. 22158 (Ramos), 29007 (Ramos & Edaño); Cuming 904* (type); *Elmer 14472; FB. 10526 (Curran), 14290 (Aguilar), 24607 (Bawan), 25494 (Aguilar), 25514 (Cenabre), 25645 (Cailipan); Hagger Dec. Phil. For. Flora 287; Merrill 2067* (paratype *C. pachyphyllum* Perk.); *PNH. 381 (Gonzalez), 18527 (Mendoza 1520); Vidal 160, 694, 695, 699, 1335.* — Leyte: *Wenzel 1284.* — Mindanao: *Elmer 11007* (type *C. melioides* Elm.); *Wenzel 3092.*

cultivated:

Fénix 274; Llehua 71; Loher 432; NBFD. A 648 (Keith), A 4204 (Wood & Wyatt-Smith).

Ecology: Primary forests, up to 500 m. *Fl.* May—July, *fr.* Oct.—Dec.(—June).

Uses. One of the sources of *manila-elemi* (together with *C. luzonicum*) and the main source of *pili nuts,* which are used as almonds, and of *pilinut oil* (Brown, *l. c.*; Burk. *l. c.*; Quis. *l. c.*) and *pili-pulp oil* (L. T. Marañon *et al.,* Philip. J. Sc. 83, 1955, 359).

Note. Related to *C. luzonicum*; specially characterized by its stiff, lingulate, persistent stipules.

20. Canarium odontophyllum Miquel, 1861, 525; 1869, 117; Engler, 1883, 108; Lam, 1929, 118; 1932a, f. 122b; 1932b, 519, f. 89; Leenhouts, 1956, 271, f. 22i. — *C. beccarii* Engler, 1883, 107. — *C. palawanense* Elmer, 1913, 1754. — *C. multifidum* Lam, 1932a, 215, f. 122c; 1932b, 520.

Type: Sumatra, W. coast, Rau, *Teysmann HB 692,* st. (U; isotype in L).

Tree, up to 35 m high, up to 50 cm in diam., with buttresses. *Branchlets* ¾—3 cm thick, densely rusty tomentose, often glabrescent; pith with a peripheral cylinder of many small vascular strands. *Stipules* persistent, inserted near or on the base of the petiole, orbicular and dentate to oblong and repeatedly slit into 2—4 cm long lobes, specially at the base and apex, 2—9 by 1½—3½ cm, minutely tomentose, subglabrescent, nervation coarse, anastomosing. *Leaves* 3—8-jugate. *Leaflets* oblong to lanceolate, 15—40 by 5—10 cm, coriaceous, sparsely pilose to densely tomentose beneath and on the midrib above; base subequilateral, broadly cuneate to subcordate; margin dentate to serrate; apex abruptly, short and slender, acute-acuminate; nervation slightly sunken above, strongly prominent beneath; nerves 15—28 pairs (angle 55—65—90°), straight to faintly curved, gradually curving towards the margin, rarely distinctly arching; intermediate veins often strongly developed. *Inflorescences* axillary, together pseudo-terminal (sometimes truly terminal?), laxly thyrsoid, densely tomentose, ♂ ones 30—50 cm long, many-flowered, ♀ ones 15—20 cm long and with few flowers. *Bracts* often persistent, grading to the stipules. *Flowers* pubescent outside, ♂ 4—7 mm long, ♀ 8—9 mm, with a slightly hollowed receptacle. *Calyx* 3-parted, ♂ 2½—4½ mm high, ♀ 8 mm. *Stamens* glabrous, ♂ adnate to the disk, ♀ inserted on its rim. *Disk* glabrous, ♂ circular, flat, slightly concave in the centre, 6-lobed, ¼—1 mm high; ♀ adnate to the receptacle, rim 1 mm high, faintly 6-lobed. *Pistil* glabrous, in ♂ flowers strongly reduced to none. *Infructescences* mostly broadly thyrsoid, 20—35 cm long, densely tomentose, with up to 40 fruits; calyx saucer-shaped, triangular, about 1½ cm in diam. *Fruits* ovoid to ellipsoid, rounded triangular in cross-section, 2½—3½ by 1¾—2 cm, glabrous, ivory-white when fresh; pyrene smooth, faintly 3-ribbed; lids ½—2½ mm thick, bony. *Seed* 1; sterile cells more or less reduced.

Taxonomy. I have subdivided this rather variable species into 2 mutually grading forms, which partly exclude each other geographically, as follows:

a. forma **odontophyllum.** — *C. beccarii* Engl.

Stipules rather small, not deeply incised. Leaflets stiff-coriaceous, woolly-pubescent beneath, nervation waffle-like prominent (leaflets very similar to those of *C. littorale* f. *rufum*).

b. forma **multifidum** (H. J. Lam) Leenhouts, *nov. stat.* — *C. multifidum* H. J. Lam.

Type: Borneo, P. Laut, Sungeiparing, at low alt., *FRI. bb. 13255*, st. (BO) *n. v.*

Stipules large and deeply incised. Leaflets thinner, less pilose beneath and nervation less prominent.

Distribution: Sumatra, Borneo, and Palawan; f. *odontophyllum* is restricted to Sumatra and W. Borneo, f. *multifidum* to N. and E. Borneo, intermediates are known from N. and E. Borneo and Palawan.

SUMATRA. *Beumée A. 484* (a); *Teysmann HB 692* (type) (a), *HB 3862* (a).

BORNEO. *Beccari PB 2790* (type *C. beccarii* Engl.) (a), *PB 3912* (a); *Dickson 7* (a); *Elmer 20975* (aff. b), *21228* (a—b); *Endert 4718* (a—b); *FRI. bb. 16161* (b), *bb. 16164* (b), *bb. 19136 (v. d. Zwaan 1182)* (a—b); *Hose 171* (a); *Kostermans 5105* (b), *6904* (b), *6942* (b), *6969* (b); *NBFD. 4436 (Castro)* (b), *4590 (Puasa)* (a—b), *4593 (Clemente)* (a—b), *9444 (Agama & Valera)* (b), *A 3961 (Wood)* (a—b), *SAN 16088 (Wood)* (a—b).

PALAWAN. *Elmer 12889* (type *C. palawanense* Elm.) (a—b).

Ecology: In primary forests, up to 450 m. *Fl.* March—April and Sept.—Oct., *fr.* May—Nov.

Uses. Wood rather soft and of little use. Seeds edible.

Notes. Taxonomy and geography. The present species, especially f. *odontophyllum*, is close to *C. littorale* f. *rufum*; the leaflets are quite identic, the stipules are similar, though slightly larger; *C. odontophyllum* differs, however, by its axillary inflorescences (in this character it is possibly more primitive than *C. littorale*), by the differently shaped disk in the ♂ flowers, and by the smaller and less variable fruits. On the other side, there is doubtless a close relationship to *C. denticulatum*, which, however, is much more slender in its habit, and possesses quite differently shaped stipules.

Forma *multifidum* is a very peculiar form, especially characterized by its stipules. In my opinion, f. *odontophyllum* represents the more primitive, f. *multifidum* the more advanced form of the species. If this is correct, the centre of origin of the species would possibly be in Sumatra, and its taxonomic source somewhere near *C. littorale* f. *rufum* (Sumatra and the Malay Peninsula).

Nomenclature: The type-specimen of the species is rather poor, it is sterile and the stipules are damaged; therefore its conspecificy with the other specimens, mentioned above, is not even beyond any doubt. For the time being, however, I preferred to maintain the current interpretation.

21. Canarium denticulatum Blume, 1826, 1162; Roemer & Schultes, 1830, 1623; Blume, 1850, 217, *incl.* also *var. latifolia*; Miquel, 1859, 644; Engler, 1883, 136; Koorders & Valeton, 1896, 39; Backer, 1911, 197; Koorders, 1912, 434; Ridley, 1922, 374; Heyne, 1927, 876; Lam, 1932a, f. 70, 104h, 123a, b and c; 1932b, 521, f. 90; 1948, 6; Leenhouts, 1956, 272, f. 21j, 22k, 37. — *C. sylvestre* (*non* Gaertn.) Blume, 1850, 217; Miquel, 1859, 644; 1861, 205; Engler, 1883, 114. — *C. fissistipulum* Miquel, 1861, 525; Engler, 1883, 115; Lam, 1932b, 524. — *C. spectabile* Miquel, 1869, 116; Engler, 1883, 147. — *C. coccineo-bracteatum* Kurz, (1870, 33, 67, *nom. nud.*) 1872, 296; Bennett, 1875a, 536; 1875b, 104; Kurz, 1877, 209; Engler, 1883, 149; King, 1894b, 246; Parkinson, 1923, 116. — *C. fuscum* Engler, 1883, 116; Koorders & Valeton, 1896, 47; Robinson, 1908, 185; Backer, 1911, 197; Koorders, 1912, 434. — *C. kunstleri* King, 1894b, 248. — *C. laciniatum* Elmer, 1911, 1084; Merrill, 1923, 350. — *C. elmeri* Merrill *ex* Lam, 1932b, 524, *in syn.*

Type: Java, Salak, *Blume 743*, st., lectotype (L).

Tree, 12—30(—50) m high, 30—80 cm in diam., sometimes with low buttresses, rarely a shrub. *Branchlets* 3—8 mm thick, minutely tomentose, usually glabrescent, sometimes lenticellate; pith with many small vascular strands, arranged into 1 or 2 peripheral cylinders. *Leaves* 2—6-jugate. *Stipules* persistent (to caducous), inserted on the petiole (0—)3—6 mm from the base, pectinate to dendriform, (½—)1—2½(—4) by ¾—1½ cm, minutely tomentose. *Leaflets* inequilateral, ovate to lanceolate, 5—20 by 2—15 cm, stiff-herbaceous to coriaceous, glabrous (rarely pilose); base cuneate to rounded or cordate, usually slightly oblique; margin entire to dentate or serrate; apex acuminate, acumen short and blunt to slender and acute; nerves 9—21 pairs (angle 65—85°), faintly curved, usually distinctly arching near the margin. *Inflorescences* axillary, together pseudo-terminal, rarely truly terminal, laxly thyrsoid, 12—35 cm long, densely (rarely sparsely) rusty tomentose; *bracts* lanceolate, grading to the stipules. *Flowers* densely pubescent, ♂ 4—5 mm, ♀ 7—8 mm, the latter with a concave receptacle. *Calyx* ♂ 3—4 mm high, ♀ 5—6 mm. *Stamens* glabrous, ♂ more or less adnate to the disk, ♀ inserted on the disk. *Disk* glabrous, in ♂ flowers annular, lobed, in ♀ flowers adnate to the receptacle except a low rim. *Pistil* glabrous, more or less stalked, in ♂ flowers strongly reduced. *Infructescences* densely tomentose, with up to 10 fruits; calyx broadly funnel-shaped, triangular, 12—14 mm diam. *Fruits* ellipsoid to ovoid or obovoid, rounded triangular in cross-section, 2½—3 by 1¼—1½ cm, glabrous; pyrene smooth; lids 1—1½ mm thick. *Seeds* (3—)1; sterile cells strongly reduced, often without a lumen.

Distribution: S. Andamans, S. Burma, Sumatra, the Malay Peninsula, Java, Borneo, and the Philippines.

Ecology: Rain forests, up to 700 m. *Fl.* mainly June—Sept., *fr.* mainly May—Nov.

KEY TO THE INFRASPECIFIC TAXA

1.a. Leaflets tomentose beneath, sometimes subglabrescent; the margin entirely serrate to dentate. *Borneo* . . . . subsp. **kostermansii**
b. Leaflets glabrous; margin entire to partly (rarely entirely) dentate. *Whole area* subsp. **denticulatum** 2
2.a. Nerves (14—)16—17(—21) pairs; lobes of the stipules broad; leaves 4—6-jugate; habit coarse. *Area as the species, S. Burma excepted* . . . f. **denticulatum**
b. Nerves (9—)11—12(—14) pairs; lobes of the stipules subulate; leaves 2—4-jugate; habit more slender. *Sumatra, Banka, Borneo* . . . f. **fissistipulum**

A. Subsp. **denticulatum**. — All synonyms.

Branchlets usually glabrescent. Leaves glabrous. Stipules persistent, inserted on the petiole, up to 6 mm from its base. Leaflets coriaceous; base oblique, rounded; margin entire to sparsely dentate towards the apex (rarely entirely dentate); apex subabruptly, long acute-acuminate. Inflorescences nearly always axillary, together pseudo-terminal, up to 25 cm long. Disk in ♂ flowers annular, 12-lobed, ¾ mm high, fleshy. Pistil not or slightly stalked, in ♂ flowers ¼—½ mm high. Calyx in fruit broadly funnel-shaped, triangular, 12—14 mm in diam. Seeds (3—)1; fertile cells circular to triangular in cross-section, sterile cells strongly reduced.

Subsp. *denticulatum*, which occupies the whole area of the species, is somewhat variable, above all in its vegetative parts. For most of the specimens it is possible to distinguish between the two following forms, which partly exclude each other geographically:

a. forma **denticulatum**. — *C. denticulatum* Bl. *incl.* also *var. latifolia* Bl. — *C. spectabile* Miq. — *C. fuscum* Engl. — *C. kunstleri* King. — *C. laciniatum* Elm.

Tree, 20—30(—50) m high, 40—80 cm in diam. In all parts rather coarse form. Leaves 4—6-jugate. Stipules pectinate, 1—2½(—4) cm long, the lobes broad, laciniate. Leaflets rather dull; nerves (14—)16—17(—21) pairs, moderately prominent beneath.

b. forma **fissistipulum** (Miq.) Leenhouts, *nov. stat.* — *C. sylvestre* Auct. — *C. fissistipulum* Miq.

Type: Sumatra, Lampongs, Tarabangie, *Teysmann HB 4415,* fr. (U; isotypes in BRSL, K, L).

Tree, 15—25(—32) m high, 30 cm in diam., sometimes a shrub. In all parts more slender. Leaves 2—4-jugate. Stipules dendriform, usually slightly smaller than in f. *denticulatum,* the lobes subulate. Leaflets shining; nerves (9—)11—12(—14) pairs, slightly sunken above, rather prominent beneath, distinctly arching, veins less conspicuous than in f. *denticulatum.* Inflorescences more lax than in the former.

Distribution: f. *denticulatum*: S. Andamans, Sumatra (also Simalur), Malay Peninsula (Perak), Java, Borneo (very rare), Philippines (Basilan and Mindanao); f. *fissistipulum*: Sumatra, Banka, and Borneo; intermediate specimens: S. Andamans, Sumatra, S. Burma, Malay Peninsula, and Borneo.

ANDAMANS. *King's coll. in herb. L 898.319—142* (a), *in herb. CAL 78275* (a), *in herb. CAL 78276* (aff. a); *Kurz in herb. CAL 78277* (syntype *C. coccineo-bracteatum* Kurz) (aff. b); *Prain's coll. 59* (a), *91* (aff. a).

BURMA. *Parkinson 1963* (a—b).

THAILAND. *Kerr 11687* (a—b).

SUMATRA. *Diepenhorst HB 2515* (type *C. spectabile* Miq.) (a); *Engles-Julius 13* (a—b); *Forbes 3156* (b); *FRI. bb. 2529 (Pieters)* (a), *bb. 3148* (a), *bb. 7394* (a), *bb. 15437* (a), *bb. 18598 (Djabar 25/V-1(* (a), *bb. 31605* (a), *bb. 32011* (aff. b), *bb. 32992 (Kidjam Ginting Soegihan 2)* (a), *T 3 P 353* (b), *T 3 P 410* (b), *TB. 478* (a); *Grashoff 182* (b); *Lambach 1349* (b); *Pringo Atmodjo 427* (a); *Van Steenis 9803* (aff. b); *Teysmann HB 4415* (type *C. fissistipulum Miq.*) (b). — Simalur: *Achmad 524* (a), *574* (a), *1278* (a), *1299* (a), *1305* (a), *1362* (a). — Banka: *Anta 1198* (b), *1026* (b).

MALAY PENINSULA. *Curtis 2710* (syntype *C. kunstleri* King) (a); *KEP. 69016* (a); *King's coll. 7041* (syntype *C. kunstleri* King) (a), *7393* (syntype *C. kunstleri* King) (a), *7509* (lectotype *C. kunstleri* King) (a); *SF. 35195 (Kiah)* (aff. b).

JAVA. *Den Berger 707* (a); *Beumée 4489* (a), *6076* (a), *6076a* (a); *Blume 742* (a), *742a* (a), *743* (lectotype) (a), *in herb. L 898.319—192* (a); *van Borssum Waalkes 570* (a); *Houtsoorten Gedeh 576* (a); *Koorders* (all -numbers) *926* (a), *927* (a), *928* (a), *929* (a), *930* (a), *931* (a), *932* (a), *933* (a), *934* (a), *935* (a), *936* (a), *937* (a), *938* (a), *939* (a), *940* (a), *942* (a), *968* (a), *972* (a), *980* (a), *981* (a), *12166* (a), *13304* (a), *13385* (a), *13433* (a), *14041* (a), *20066* (a), *21899* (a), *24158* (a), *24609* (a), *25514* (a), *29170* (a), *34151* (a), *36764* (a); *Unknown coll. in herb. L 898.319—193* (a), *in herb. L 898.319—200* (type *C. denticulatum var. latifolia* Bl.) (a).

BORNEO. *Clemens 7009 (Sar. mus. 20187)* (aff. b), *7369 (Sar. mus. 22187)* (b); *Elmer 20575* (b), *20959* (b), *21145* (b), *21251* (b), *21614* (b); *Endert 5117* (b), *5407* (b); *Jaheri 820* (b), *1022* (b), *1182* (b); *KEP. 80502 (Wyatt-Smith)* (b); *NBFD. 1731 (Puasa)* (b), *3992 (Agama)* (b), *4539 (Puasa)* (b), *4628* (aff. b), *4781 (Otik)* (b), *7073 (Balajadia)* (b), *7098* (b), *8825 (Enggoh)* (aff. b), *9301 (Keith)* (b), *A 527 (Castro)* (aff. b), *A 793* (b), *A 801* (b), *A 851* (b), *SAN 15392 (Wood & Charington)*, *SAN 16001 (Wood)* (b), *SAN 16294 (Wood)* (a), *SAN 16548* (b), *SAN A 4667 (Wood)* (b), *SH 8825 (Enggoh)* (a—b), *SH 10628 (Puasa & Enggoh)* (b); *SF. 27177 (Carr)* (a—b); *D. D. Wood 2270* (b).

PHILIPPINES. Basilan: *FB. 18843 (Miranda)* (a); *Vidal 2286* (a). — Mindanao: *BS. 83501 (Ramos & Convocar 143)* (a), *83615 (Ramos & Convocar 403)* (a); *Elmer 11122* (type *C. laciniatum* Elmer) (a), *13291* (a); *FB. 13279 (Foxworthy c.s.)* (a), *20742 (Rafael & Ponce)* (a); *Wenzel 2635* (a); *Williams 2181* (a), *2870* (a).

locality unknown:

Unknown coll. in herb. L 898.319—209 (type *C. fuscum* Engler) (a).

Wood anat.: See Moll & Janssonius, Mikrogr. d. Holzes 2, 1908, 107.

B. Subsp. **kostermansii** Leenhouts, 1955b, 181; 1956, 272.

Type: E. Borneo, Sangkulirang Subdiv., Sg Menubar reg., alt. 30 m, June 15, 1951, *Kostermans 5226*, ♀ (L; isotypes in BM, BO, K).

All parts long remaining ferruginous pubescent. Leaves 2—4-jugate. Stipules as in f. *denticulatum*. Leaflets stiff-herbaceous, densely pubescent beneath and on the midrib above, more or less glabrescent; base nearly equilateral, rounded to broadly cuneate; the whole margin densely serrate (to dentate); apex gradually acuminate, acumen short and slender; nerves (14—)18—20 pairs, less distinctly arching than in the foregoing subsp. Inflorescences up to 35 cm long, lax and many-flowered.

Distribution: East Borneo.

BORNEO. *FRI. bb. 10751* (paratype), *bb. 12237* (paratype); *Kostermans 5112* (paratype), *5226* (type), *5300* (paratype), *5395* (paratype), *5907* (paratype), *5921* (paratype).

Taxonomy. The present species is especially closely related to *C. odontophyllum* and *megalanthum*, which are both distinctly more coarse in habit; moreover the former is different by the strongly prominent nervation and venation and the dense tomentum on the lower side of the leaflets, the second one by its exceptionally large flowers.

Furthermore, the present species seems to be related to *C. manii*; from the latter it is distinctly different, however, by its deeply incised stipules and its nearly exclusively axillary inflorescences.

Geography. Noteworthy is the geographical position of both forms of subsp. *denticulatum*. The area of f. *denticulatum* seems to be disjunct; the gap which is formed by Borneo (except for one specimen in the north, and some intermediate specimens) is filled up by f. *fissistipulum* (which possibly is the more evolved one, according to its stipules, and as it is in general more different from the related species).

22. Canarium karoense H. J. Lam, 1932a, 215, t. 15 f. 120a; 1932b, 514, t. 13 f. 87; Leenhouts, 1956, 274.

Type: Sumatra, E. coast, Karolands, Lao Pengulu, Dec. 18, 1927, *FRI. bb. 12512*, ♀ (BO; isotype in L).

Tree. *Branchlets* c. 1 cm thick, minutely tomentose, glabrescent; pith with a number of peripherally arranged small vascular strands. *Stipules* persistent, inserted partly or entirely on the base of the petiole, ovate to lanceolate, coarsely pectinate, 1½—5 by 1½—3 cm, subcoriaceous, glabrous, lobes blunt, nervation anastomosing. *Leaves* 4—7-jugate, glabrescent. *Leaflets* ovate to oblong, 8—22 by 4—8 cm, subcoriaceous, glabrous; base broadly cuneate to rounded; margin entire; apex subabruptly, short- and blunt-acuminate; nerves 10—15 pairs (angle 55—70°), curving, not distinctly arching. *Inflorescences* (♂ unknown) axillary, narrowly thyrsoid to racemose, 5—9 cm long, tomentose. *Flowers* unknown. *Calyx* in very young fruits 12 mm high, tomentose. *Stamens* and *disk* unknown. *Pistil* glabrous, stalked. *Infructescences* and *fruits* unknown.

Distribution: Sumatra.

SUMATRA. *FRI. bb. 12512* (type).

Ecology: Frequent in old forests, altitude unknown. *Fl.* Nov.—Dec.

Note. Possibly conspecific with *C. megalanthum*.

23. Canarium megalanthum Merrill, 1926a, 81; Lam, 1932a, t. 11 f. 68, t. 16 f. 127 d 1; 1932b, 446, t. 9 f. 55; Leenhouts, 1956, 274, f. 22j. — *Fig. 17.*

Type: North Borneo, near Weston, at low alt., March 1924, *Wood 1213*, ♀ (UC; isotypes in A, K, L).

Tree up to 40 m by 60—70 cm, without buttresses. *Branchlets* ½—1 cm diam., rusty-tomentose; pith with a peripheral cylinder of scattered vascular strands. *Stipules* subpersistent, inserted on the petiole at ¼—¾ (—3) cm from its base, 6—8 by 10—20 mm, deeply 3—4-lobed, stiff, densely and minutely fulvous-tomentose. *Leaves* (3—)4—5-jugate. *Leaflets* obovate, lanceolate or oblong, 9—20 by 4½—8½ cm, coriaceous, glabrescent; base oblique, cuneate to cordate; margin entire; apex gradually to abruptly, shortly and slenderly acute-acuminate; nerves (10—)13—19 pairs (angle 60—70°), faintly curved, abruptly, usually distinctly, arching close to the margin. *Inflorescences* pseudoterminal to terminal, terminal ones broadly and laxly thyrsoid, 25 cm long (♀), main branches up to 9 cm, with few flowers; pseudoterminal ones narrowly thyrsoid, 25—30 cm long (♂), main branches 6—11 cm, thyrsoid, *c.* 10-flowered; minutely tomentose. *Flowers* pubescent, ♂ 8—11 mm, ♀ 13—15 mm. *Calyx* broadly cupular, ♂ 7 mm,

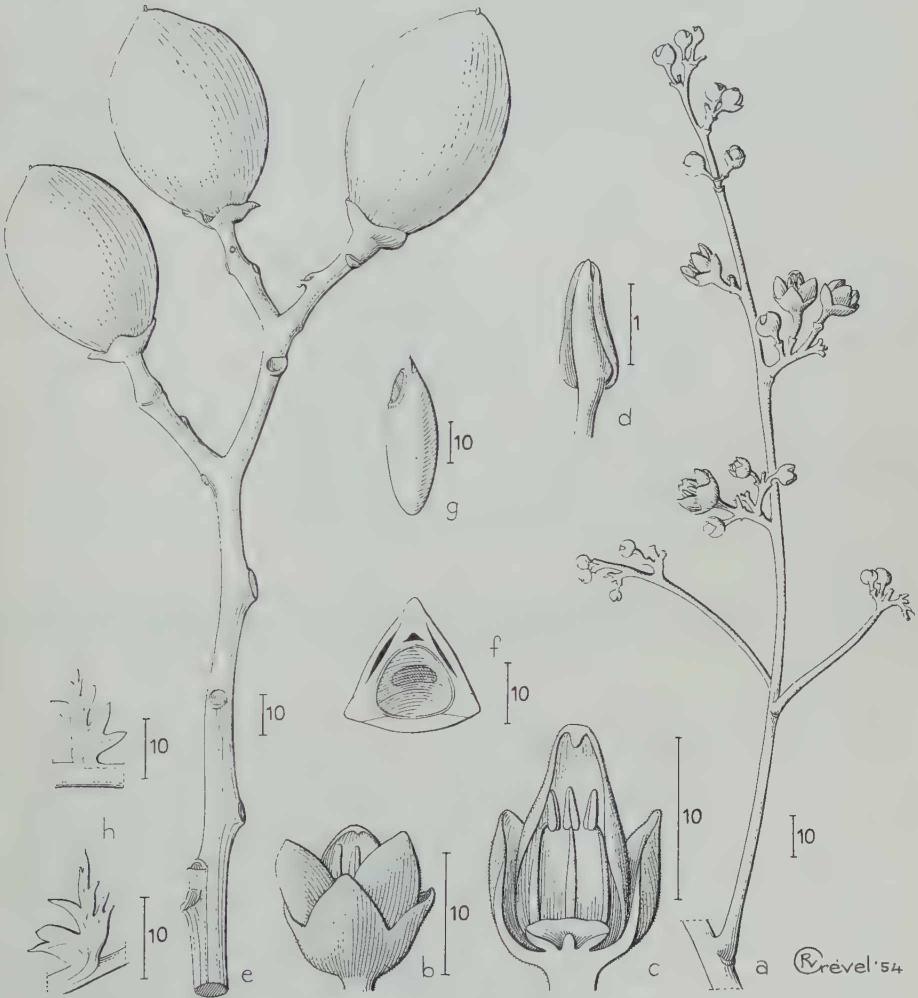


Fig. 17. *C. megalanthum* — a. ♂ inflorescence; b. ♂ flower; c. ditto in section; d. anther from dorsal; e. infructescence; f. pyrene in cross-section; g. seed; h. stipules. (a—d & h. from *Beccari PS 686;* e—g. from *SF. 21916*) (dimensions in mm).

♀ 9 mm. *Corolla* ♀ pubescent at both sides, ♂ inside glabrous. *Stamens* adnate to the disk, filaments glabrous. *Disk* glabrous, ♂ saucer-shaped, 1 mm high, rim undulate; ♀ cupular, 2½—3 mm high, truncate. *Pistil* long-pilose; ♂ none. *Infructescences* c. 25 cm long, sparsely tomentose, with 4—5 fruits; calyx saucer-shaped, 3-lobed, 2—2½ cm diam. *Fruits* ellipsoid, sometimes acute, bluntly triangular in cross-section, 5—5½ by 3½—4 cm, sparsely, near the apex densely, ferruginously tomentose; pyrene smooth with 3, blunt to acute, angle-ribs, specially near the apex; lids 1—2 mm thick. *Seed* 1, spindle-shaped, acuminate at base, 4 by 1½ cm; fertile cell in cross-section circular, 1½ cm diam., sterile cells strongly reduced, without lumen.

Distribution: Sumatra, Malay Peninsula, Borneo.

SUMATRA. *Beccari PS 686.*

MALAY PENINSULA. *KEP. 45015 (Symington), 65589 (Cousens); SF. 21916 (Henderson).*

BORNEO. *Dario A 3359; KEP. 35517 (Symington); Kostermans 7097; NBFD. 4844 (Puasa), SAN 16341 (Wood); D. D. Wood 1213* (type).

Ecology: Rain-forests, up to 360 m. *Fl.* Sum.: Aug., Borneo: March—May, *fr.* May—July.

Uses. The wood is said to be hard. In Brunei this species is cultivated for its edible seeds which are among the largest of this genus. The resin is said to be abundant.

Notes. A rather remarkable species, without any doubt related to *C. denticulatum,* and possibly conspecific with the insufficiently known *C. karoense.*

Characterized by its rather large flowers and fruits; moreover, specimens in the herbarium often show black resin on the branches and the fruits, like in many *Anacardiaceae,* a feature which is very rare in *Burseraceae.*

24. Canarium manii King, 1894b, 247; Parkinson, 1923, 116. — *Fig. 18.*

Type: S. Andamans, Hobdaypore and Iusonabad, July 12, 1890, *King s. n. in herb. CAL 78302,* fr., lectotype (CAL; isotypes in BM, K).

Medium-sized to large deciduous tree. *Branchlets* 3—5 mm thick, scabrous, lenticellate, minutely pubescent, glabrescent, leaf-scars prominent; pith with a peripheral cylinder of vascular strands. *Leaves* 2—4-jugate. *Stipules* very caducous, inserted on the petiole 3—13 mm from its base, orbicular, c. 6 mm diam., leaving a distinct, drop-shaped scar. *Leaflets* ovate-lanceolate, the terminal ones elliptic, 8—14 by 3½—7 cm, thin coriaceous, glabrous; base of laterals slightly oblique, cuneate to cordate; margin entire, slightly revolute; apex rather abruptly acuminate, acumen slender, 8—15 mm long, blunt; nerves 9—12 pairs (angle 65—80°), basal ones sinuate, all others faintly curved to nearly straight, interarching close to the margin. *Inflorescences* terminal, thinly minutely pubescent, ♂ ones thyrsoid, 10—12 cm long, branches —4 cm long, ♀ ones subracemose, c. 7 cm long, branches —2½ cm long; bracts orbicular to lanceolate. *Flowers* densely pubescent, the ♂ ones 4—5 mm long, ♀ ones 7—8 mm, receptacle of the latter up to 1½ mm deep. *Calyx* in ♂ flowers c. 1 mm, in ♀ flowers 5—6 mm. *Stamens* 6, glabrous, ♂ slightly confluent at the base, ♀ inserted on the margin of the disk. *Disk* glabrous, in ♂ flowers rather variable, always strongly developed, solid and conical or with a narrow central canal, in ♀ flowers connate with the receptacle except the margin. *Pistil* glabrous, distinctly stalked, in ♂ flowers absent. *Infructescences* with 1—2 fruits; the calyx flat, faintly 3-lobed, *c.* 9 mm in diam. *Fruits* ovate to obovate, elliptic to blunt-triangular in cross-section, 27—30 by 14—16 mm, glabrous, papillose; pyrene smooth; lids 2—3 mm thick. *Seed* 1; the fertile cell inside with a distinct peripheral rib; sterile cells strongly reduced.

Distribution: Middle and South Andaman.

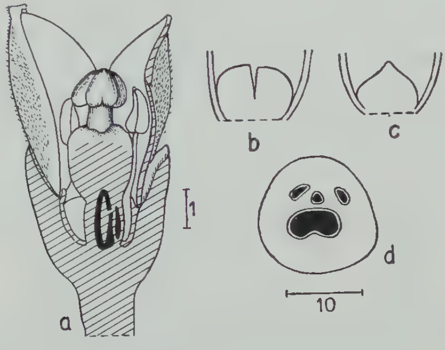


Fig. 18. *C. manii* — a. longitudinal section of ♀ flower; b. and c. longitudinal sections of pistilloid in ♂ flower; d. pyrene in cross-section. (a. from *Parkinson 1137;* the other figures from unnumbered specimens) (dimensions in mm).

ANDAMANS. Middle Andaman: *Parkinson 19, 1137.* — South Andaman: *King s.n. in herb. CAL 78301* (syntype), *78302* (lectotype), *78304, 78305, 78307, 78308* (all syntypes); *King's coll. in herb. CAL 78303, 78306* (syntype), *78309* (syntype). — Rutland Island: *Parkinson 1080.*

Ecology: Not uncommon; jungle with *Podocarpus neriifolia* Don and *Dipterocarpus* spp., at sea-level as well as on high hills. *Fl.* Febr.—April, *fr.* April—July.

Notes. This species seems to be related both to *C. denticulatum* and particularly to *C. zeylanicum.* From the former it distinctly differs by its not incised stipules and its terminal inflorescences; from the latter by its narrower leaflets, which are moreover shining on the upper surface, by its more lax nervation (since the intermediate veins are not strongly developed), by its more lax ♂ inflorescences, by its not acuminate anthers, by the disk in the ♂ flowers being not always solid (as apparently is the case in *C. zeylanicum*), and by its smaller fruits and calyces in fruit.

25. Canarium zeylanicum (Retz.) Blume, 1850, 218; Thwaites, 1858, 79; Beddome, 1871, t. 128; Bennett, 1875a, 532; 1875b, 103; Engler, 1883, 113, t. 3 f. 1—2, *excl. syn. C. commune Wight et Arnott*; Potter, 1891, t. 46 f. 4; Trimen, 1893, 239; Volkens, 1898, 168; Stepowski, 1905, 26,

f. 9—13; Merrill, 1917, 304; Lewis, 1926, 15; Petch, 1930, 282; Fischer, 1932, 53; Leenhouts, 1956, 262, f. 25. — *Kaekuriaghaha* Hermann, 1717, 52; Burmann, 1737, 28, *excl. syn. Hort. Malab. and Plukenett*; Linné, 1748, 234. — *Kaekuriaghaha odorata* Burmann, 1741, 153. — *Amyris zeylanica* Retzius, 1786, 25; Willdenow, 1799, 337; Kunth, 1824, 349, *sub. gen. Balsamodendron*; Sprengel, 1825, 218. — *C. balsamiferum* (*non* Willd.) Moon, 1824, 68. — *Balsamodendron zeylanicum* Kunth *ex* De Candolle, 1825, 76. — *Colophonia zeylanica* Paxton, 1849, 139. — *C. auriculatum* Winkler, 1908, 279.

Type: Ceylon, *herb. Koenig s. n.*, y. fl. (LD).

Large, buttressed tree. *Branchlets* 4—6 mm thick, the young parts densely minutely fulvous-tomentose, more or less glabrescent, slightly lenticellate; pith reddish-brown, shining, usually with a peripheral cylinder of small vascular strands, sometimes with scattered large white idioblasts. *Leaves* 3—4-jugate. *Stipules* early caducous, inserted on the petiole at 4—11 mm from its base, orbicular, about 1 cm diam. *Leaflets* elliptic-obovate, 8—14 by 4—7½ cm, herbaceous to coriaceous, glabrous; base equal to slightly oblique, rounded to slightly cordate; margin entire, sometimes slightly undulated, in dried specimens often revolute; apex gradually to rather abruptly acuminate, acumen cuneate or slender, up to 1 cm long, blunt; nervation slightly sunken above, rather prominent beneath, nerves 12—14—18 pairs (angle 45—80°), faintly curved, abruptly, distinctly arching near the margin; intermediate veins often strongly developed. *Inflorescences* terminal, sparsely, minutely, fulvous-tomentose, ♂ ones thyrsoid, 14—20 cm long (28 cm long and very broadly thyrsoid in the type of *C. auriculatum*), with a long branch at the base, ♀ ones narrowly thyrsoid to racemose, 7 cm long, with about 8—10 flowers. *Flowers* tomentose, ♂ ones 5 mm, ♀ 8½ mm, receptacle of the latter cupular, 1½ mm deep. *Calyx* 3½ mm, sepals more than halfway connate. *Stamens* 6, free, glabrous. *Disk* glabrous, in ♂ flowers solid, 1 mm high, in ♀ ones adnate to the receptacle, sometimes with a faint free margin. *Pistil* stalked, glabrous, in ♂ flowers absent. *Infructescences* small, lenticellate, with about 4 fruits; calyx flat, faintly 3-lobed, 1¼ cm diam. *Fruits* obovoid, 4½ by 2 cm, glabrous; pyrene nearly smooth, circular in cross-section; lids up to 5 mm thick; 1—2-seeded, the fertile cell(s) with a strong abaxial median rib, sterile one(s) strongly reduced.

Distribution: Ceylon.

CEYLON. *Christison 494; Conservator of Forests, Kandy, in herb. DD 35828; Hügel 3703; herb. Koenig s.n.* (type *Amyris zeylanica* Retzius); *Koenig in herb. L 898.319—385; Thwaites CP 2649.*

CAMEROONS. *Winkler 1157* (type *C. auriculatum* Winkler), apparently naturalized.

cultivated:

The greater part of the specimens examined originated from trees, cultivated a. o. in the botanical gardens at Bogor (*VII B 13*), Calcutta (a. o. *Pierre 4241*), Peradeniya, and from Port of Spain, Trinidad (*Dean 13328*); moreover the species has been tested as a shade-tree in Victoria, Cameroons (*c. f.* Volkens, *l. c.*).

Ecology: "Warm moister parts of the island, up to an elevation of 1500 ft." (Thwaites, 1864); "most frequently found in shallow soil, often on mere crusts of earth overlying slab rock, or on ridges. The fruits are eaten by mynas. Monkeys eat the fleshy exterior." (Lewis, 1926); "common." (Trimen, 1893). *Fl.* May—Sept. (March in Cameroons), *fr.* March.

Wood anat.: "Wood rather light and soft, even grained, white." (Trimen, 1893).

Uses. In the Cameroons used as a shade-tree in nutmeg-plantations (Volkens, 1898). Wood sometimes used for the manufacture of tea-boxes. Resin used for lighting; the smoke is reputed to drive away snakes. The seeds are eaten.

Taxonomy: Related to *C. paniculatum* from Mauritius, and to *C. manii* from the Andamans.

Nomenclature. Incorrectly, in Index Kewensis 1 the name "*Amyris elemifera* Koenig *ex* Blume, Mus. Bot. 1, 1850, 218" is mentioned as a synonym of the present species. Blume, *l. c.*, cited as a synonym of *C. zeylanicum* "*Amyris Elemifera* (*haud* Linn.) Herb. Koenig.", which refers to a manuscript note on Koenig's specimen at Leyden.

Likewise Engler, *l. c.*, erroneously cited "*Canarium commune* Wight et Arnott, Prod., 1834, 175" as synonymous with the present species. From the original publication it is evident, that the combination just quoted never has been intended to be published as a new species, but as an interpretation of *C. commune* L.; according to the description *C. vulgare* Leenh. has been meant; the synonymy is very broad and includes moreover *C. zeylanicum* and *C. paniculatum*.

26. Canarium paniculatum (Lamk) Bentham *ex* Engler, 1883, 124; Guillaumin, 1909d, 140. — *Bursera paniculata* Lamarck, 1786, 768; Du Petit-Thouars, 1811, 40. — *Colophonia mauritiana* De Candolle, 1825, 79; Delessert, 1837, t. 56. — *C. mauritianum* Blume, 1850, 217; Vaugham and Wiche, 1941, 127, pl. 4. — *C. colophonia* Baker, 1877, 44, *nom. illeg.*; F. G(leadow), 1905, 167, t. 13. — *Fig. 19.*

Type: Isle de France, *Commerson s. n.*, ♂ (P; isotypes in BM, FI, L).

Tree, 10—16 m high, up to 2 m in diam. *Branchlets* ½—1 cm thick, glabrous, rather gnarly, lenticellate, with crowded, prominent leaf-scars; pith usually with a peripheral cylinder of vascular strands. *Leaves* 2—6-jugate, glabrous. *Stipules* caducous, inserted on the base of the petiole, auricle-shaped, c. 2 mm, the scars prominent, drop-shaped. *Leaflets* broad-elliptic to broad-ovate, 7—13 by 4½—8 cm, chartaceous to subcoriaceous; base (truncate to) cordate (rounded in the terminal leaflet); margin entire; apex subabruptly acuminate, acumen short, broad, and blunt; nerves 9—12 pairs (angle about 65°), the basal ones sinuous, the other ones straight to faintly curved, abruptly, usually distinctly arching close to the margin. *Inflorescences* terminal, thyrsoid, ♂ ones 15—20 cm, scurfy, ♀ 12—15 cm, rather densely tomentose. *Flowers* tomentose, ♂ ones 6 mm, ♀ 7 mm, the latter with a hollowed receptacle. *Calyx* 2½—3½ mm high. *Stamens* 6, glabrous, in ♂ flowers free, in ♀ ones slightly confluent at base and inserted on the margin of the disk. *Disk* glabrous, in ♂ flowers solid, faintly 6-lobed, 1 mm high, in ♀ flowers adnate to the receptacle, without or with a very faint free margin. *Pistil* glabrous, stalked, in ♂ flowers absent. *Infructescences* about 18 cm, subracemose, with few fruits, especially the lower ones long-stalked; calyx flat, nearly orbicular, 1¼ cm diam. *Fruits*

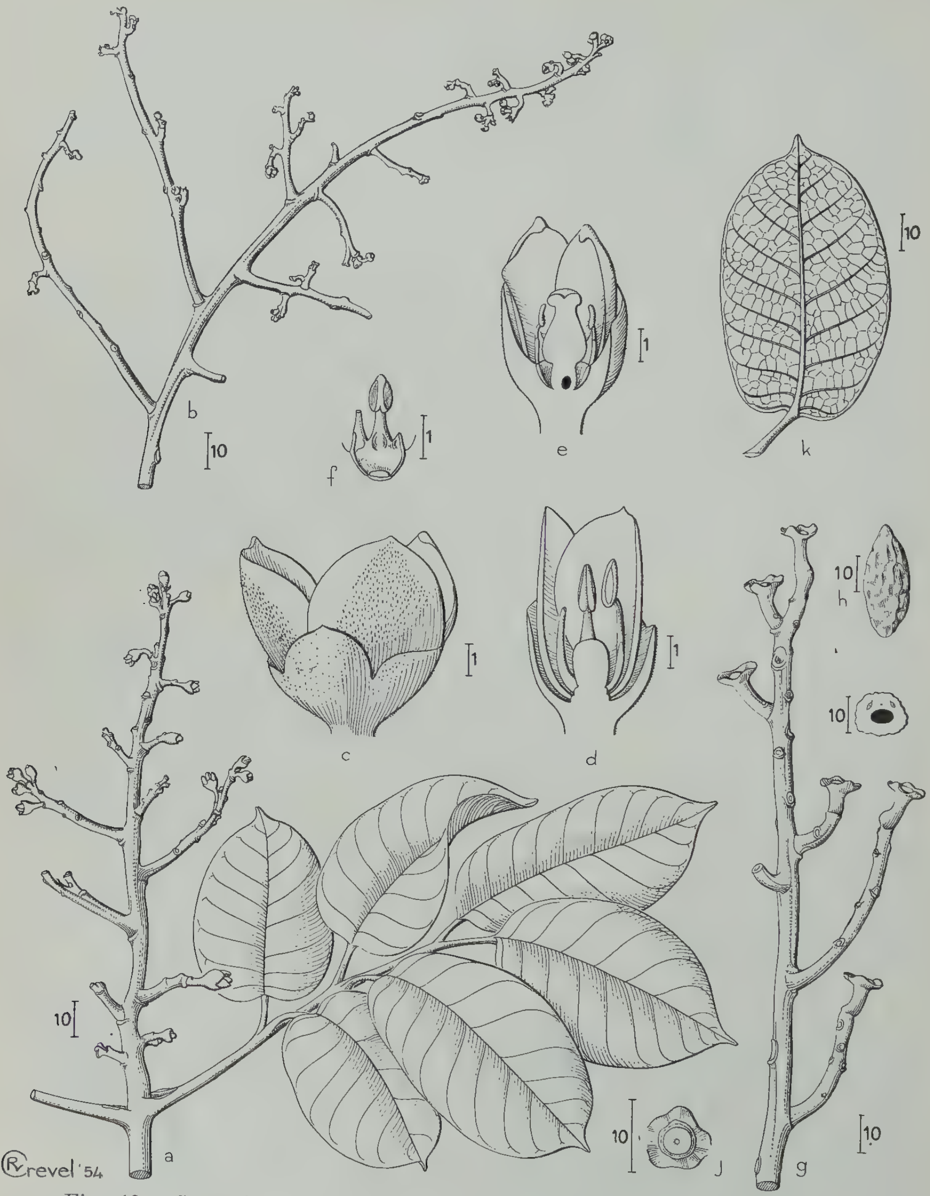


Fig. 19. *C. paniculatum* — a. twig with ♀ inflorescence; b. ♂ inflorescence; c. ♂ flower; d. ditto in section; e. ♀ flower in section; f. ditto detail, pistil removed; g. infructescence; h. fruit-kernel; i. ditto, cross-section; j. calyx in fruit; k. leaflet, lower side. (all from unnumbered specimens) (dimensions in mm).

long-ovoid, 3¼ by 1¼—1½ cm, glabrous; pyrene faintly rugged; lids 2½—4 mm thick; 1-seeded, sterile cells nearly entirely reduced.

Distribution: Mauritius.

MAURITIUS. *Aublet s.n.; Ayres s.n.; Bijoux 275, 276, 277; Blackburn s.n.; Boivin s.n.; Commerson s.n.* (type); *Martin s.n.; Richard s.n.; Du Petit-Thouars s.n.; Vaugham 395.*

Ecology: Inland- and mountain forests, apparently still common, though nearly not regenerating (see also Vaugham and Wiche, *l. c.*). *Fl.* Nov., *fr.* Nov., Febr.

Uses. The timber (*bois de colophane*) and the resin (*Mauritius elemi*) are of some importance (*cf.* Heckel, Bull. Imper. Inst. 8, 1910, 11, and Guillaumin, Agric. prat. Pays chauds 9, 2, 1909, 47 respectively).

Notes. Morphology. Resin abundant, clear. Flowers purple.

Taxonomy: Related to *C. zeylanicum* and *C. madagascariense.*

Nomenclature. The name *Canarium colophonia* Baker is illegitimate, since two older synonyms, viz. *Bursera paniculata* Lamk and *Colophonia mauritiana* DC., were mentioned.

27. **Canarium madagascariense** Engler, 1883, 111; Baillon, 1892, t. 227; Guillaumin, 1909d, 139; Perrier de la Bâthie, 1944, 286; 1946, 43, f. 10. — ? *C. harami* Bojer, 1837, 83, *nom. nud.*; Guillaumin, 1909c, 47; 1909d, 140. — *C. boivinii* Engler, 1883, 110; Baillon, 1892, t. 228; Guillaumin, 1909c, 46; 1909d, 139; Perrier de la Bâthie, 1944, 286; 1946, 45. — *C. multiflorum* Engler, 1883, 128; Baillon, 1892, t. 229, 230; Guillaumin, 1909c, 47; 1909d, 139; Perrier de la Bâthie, 1921, 203. — *C. obtusifolium* S. Elliot, 1891, 10; Guillaumin, 1909d, 139. — *C. liebertianum* Engler, 1899, 270; 1915, 782; 1931, 446; Brenan & Greenway, 1949, 78. — *C. pulchre-bracteatum* Guillaumin, 1909b, 72; Perrier de la Bâthie, 1944, 286; 1946, 46.

Type: Madagascar, Nossi-Bé, 1840, *Richard 340,* ♂ (P).

Tree, about 12—30(—35) m high, 30—60 cm (—2 m) in diam., often buttressed. *Branchlets* 4—12 mm thick, glabrous or short fulvous-tomentose, glabrescent, moderately lenticellate; pith with a peripheral cylinder of some to many small vascular strands, and usually with in the central part some to many small vascular strands, scattered or forming a second cylinder. *Leaves* 2—9-jugate. *Stipules* (sub-)caducous, sometimes persistent, inserted on the petiole up to 2 cm from its base, auricle-shaped or orbicular, rarely lingulate, glabrous to minutely fulvous-tomentose; scars often prominent. *Leaflets* lanceolate, ovate, elliptic or obovate, 4—20 by 2½—10 cm, chartaceous to coriaceous, smooth or bullate, glabrous above except the sometimes minutely tomentose midrib, beneath glabrous to hispidly pilose on the nerves; base cuneate to cordate; margin entire; apex blunt or gradually to rather abruptly acuminate, acumen short, broad and blunt; nervation more or less prominent beneath, nerves 7—20 pairs (angle 65—85°), straight to faintly curved, distinctly arching. *Inflorescences* terminal and in the upper leaf-axils, racemose to broadly thyrsoid, 5—35 cm long, densely ferruginously tomentose to subglabrous. *Flowers* 3—12 mm, tomentose, in ♀ flowers the receptacle concave. *Calyx* 2—4 mm high. *Stamens* 6, more or less adnate to the disk. *Disk* in ♀ flowers sometimes minutely pubescent, adnate to the receptacle, the free rim faintly 6-lobed, in ♂ flowers cushion-shaped, faintly 6-lobed, with a narrow central canal, glabrous. *Pistil* usually partly or entirely pilose; in ♂ flowers absent. *Infructescences* small to rather large, usually lax, the branches slender to coarse, with few to many fruits; calyx flat, orbicular, ¾—1½ cm diam. *Fruits* circular, rounded triangular or rounded 6-angular in cross-section, 2½—5½ by 1½—3¼ cm, nearly always pustular-lenticellate, usually tomentose when young; pericarp thick and fleshy; pyrene circular or rounded 3—6-angular in cross-section, usually smooth, near the base and apex with 3 angle-ribs and sometimes 3 faint median ribs; lids 2—4(—6) mm thick, bony; 1(—3)-seeded, the fertile cells with a strong abaxial median rib.

Distribution: East Africa: Tanganyika, Mozambique; Madagascar.

Taxonomy. The present species is an extremely variable one; in many characters it is possible to distinguish between some rather or even very different types, which are, however, usually not sharply delimited. These variable organs and their distinguishable types are:

Leaflets. Described under the subspecies, which are primarily based on the variations of the leaflets. The type of subsp. *bullatum* stands isolated; the types of subsp. *madagascariense* and *obtusifolium* are connected by many intergrades and they are probably mainly defined by the climate.

Inflorescences and *flowers.* As a whole the following types are clearly distinguishable:

♀ : (The differences between the three types seem to be far too great for subspecies, the more so as intermediates are unknown. However, the material is very scanty — only 6 specimens out of a total of about 100 — and none of the types shows a distinct correlation either with the ♂ flowers and inflorescences, or with the infructescences, or even with the vegetative parts. The variation of these characters deserves to be studied in the field, making use of more plentiful material.)

1. *Inflorescences* broadly thyrsoid, up to 25 cm long, densely ferruginously tomentose. *Flowers* 6—7 mm, minutely brown-tomentose. *Pistil* densely pilose except the stalk and the style. This type only occurs in subsp. *madagascariense.*

2. *Inflorescences* smaller, rather lax. *Flowers* c. 3 mm, minutely grey-tomentose. *Pistil* pilose. Restricted to subsp. *madagascariense.*

3. *Inflorescences* 5—10 cm, racemose to narrowly thyrsoid. *Flowers* 12 mm (in *C. pulchre-bracteatum* they are even described as being 17 mm, but I suspect this to be a printing error; the type-specimen has now no flowers at all), densely ferruginous-tomentose. *Pistil* pilose or glabrous. Neither geographically nor morphologically correlated, and therefore not restricted to any one of the subspecies.

♂ : 1. *Inflorescences* broadly thyrsoid, 15—30 cm long, glabrous except the minutely tomentose ultimate parts; branches oblique to transverse, up to 20 cm long, broadly paniculate, many florous; bracts lanceolate to subulate, 5 by ¾ mm (*Uersch herb. L 939.69—90*: elliptical, 4 by 2½ mm). *Flowers* c. 5 mm, minutely ferruginously to grey tomentose. *Stamens* slightly confluent to the disk (*Uersch as above*: adnate to the disk); anthers 1¾ and 1¼ mm, acute. *Disk* ¾ mm high. This type is restricted to subsp. *madagascariense.*

2. *Inflorescences* 20—35 cm, rather densely stellate tomentose; branches

few, transverse, up to 15 cm long, the flowers more or less clustered; bracts subulate to elliptic, 5 by 1—4 mm. *Flowers* 7 mm, rather densely ferruginously tomentose. *Stamens* adnate to the disk; anthers 2 mm, blunt. *Disk* 2 mm high. This type is restricted to subsp. *bullatum.*

3. *Inflorescences* paniculate, 10—15 cm long, sparsely brown tomentose; sometimes with a rather long branch in the upper leaf-axil, furthermore branches few, up to 2½ cm long, flowers clustered; bracts usually broadly elliptic to ovate, rather persistent, 6 mm long. *Flowers* 7—8 mm, densely ferruginously tomentose. Otherwise identical with type 2. This type is mainly to be found in subsp. *obtusifolium.*

Infructescences and *fruits.*

1. Sharply delimited are some specimens with smooth *fruits*, which are about globular to ellipsoid, 3 by 2 cm. *Infructescences* small and with few fruits; calyx flat, orbicular, 1½ cm in diam., thin. *Leaflets* usually not very large, coriaceous. This type is represented by the following specimens: *Humbert 20369, Perrier 14013, R. N. 28—51, Service forestier 854 & 2388*, all from the eastern part of Madagascar. Though this group is sharply delimited in its fruit characters, this is in my opinion not sufficient for basing a new taxon upon.

2. *Fruit* globular to ellipsoid, about 2½—3 by 1½—2 cm. *Infructescences* rather large, lax; the axes slender; calyx flat, thin, ¾ cm diam. This type is represented in subsp. *madagascariense* and *obtusifolium* and specimens, which are intermediate between these two. It is vaguely delimited against type 3.

3. Mainly differing from type 2 by the *fruits*, which are always more oblong (3—3½ by 1¾—2½ cm) and by the fruit-bearing calyx, in which the thin margin is sharply delimited against the central part, which is tapering into the pedicel. This type is to be found in specimens typical of or close to subsp. *madagascariense.*

4. Close to the types 2 and 3. *Fruits* globular to oblong, 3—4 by 2½ cm. *Infructescences* large and coarse, the axes thick, pedicels short and thick; calyx flat, rather thin, 1½ cm diam. This type is restricted to subsp. *bullatum.*

5. *Fruits* large, ellipsoid, 4—5½ by 2½—3¼ cm, often only partly pustular-lenticellate, sometimes with remainders of the indumentum. *Infructescences* large, the axes thick, as are the pedicels; calyx 1½—2 cm diam., the narrow, thin margin sharply delimited against the semiglobular, ½—¾ cm high, central part. This type is restricted to subsp. *obtusifolium.*

From the above it may be clear, that the variability of this species is considerable, and that regarding some organs it is even possible to distinguish between some very different types. As, however, most of these variations do not correlate at all, or only slightly, with each other, and as they are usually not geographically defined, it is in my opinion not justified to split up the present species into some, which would be only vaguely demarcated against each other.

Mainly on account of the leaf-characters, which correlate more or less with some of the variations in the male inflorescences and in the infructescences and fruits, and which are rather strictly geographically defined (very probably as a consequence of the climatological differences between the western and the eastern part of Madagascar), I propose a subdivision of the species into 3 subspecies. I am quite aware, that this subdivision is a provisional one, which does not fully justice to the variability of the species, and that, if more material and more field-knowledge is available, possibly some of the variations mentioned above may prove to characterize distinct local populations, which must be valued as well-defined varieties or even taxa of higher rank; the same might be the case regarding some deviating specimens.

KEY TO THE SUBSPECIES

1.a. Leaves 4—6-jugate; leaflets 12—20 by 6—10 cm, subcoriaceous, bullate, pilose on the nerves below, the base distinctly cordate, the apex abruptly acuminate. Infructescences very coarse. *N.E. Madagascar* . . . . . subsp. **bullatum**

b. Leaves 3—9-jugate; leaflets usually smaller and especially narrower, nearly always glabrous, the base cuneate to faintly cordate, the apex (blunt to) gradually acuminate. Infructescences more slender 2

2.a. Leaves (3—)7—9-jugate, deciduous; leaflets ovate to elliptic, 8—15½ by 3—6 cm, stiff chartaceous, the base rounded to subcordate, the apex gradually long-acuminate. Inflorescences and infructescences large. *W. Madagascar & E. Africa* . . . . subsp. **madagascariense**

b. Leaves 2—4-jugate, not deciduous; leaflets usually smaller, coriaceous; the base usually acute; the apex rounded or subabruptly minutely acuminate. Inflorescences rather small, narrowly paniculate, few-flowered. *E. Madagascar* subsp. **obtusifolium**

A. Subsp. **madagascariense** — *C. multiflorum* Engl. — *C. liebertianum* Engl.

Leaves deciduous, (3—)7—9-jugate, usually glabrous. Leaflets ovate to elliptic, 8—15½ by 3—6 cm, stiff-chartaceous to coriaceous, sometimes hispidly pilose on the midrib beneath and especially in the nerve-axils; base (acute to) rounded to faintly cordate; margin entire; apex gradually acuminate, acumen short, broad, and blunt; nerves 8—12(—14) pairs (angle 65—75°), mutual distance (½—)1—1½ cm, straight, gradually curved towards the margin, gradually arching at about 2 mm from the margin; veins transverse, rarely intermediate ones well-developed. Inflorescences and flowers ♂ type 1, ♀ type 1 and 2. Infructescences and fruits type 2 and 3.

Distribution: Tanganyika (*incl.* also Mafia island), Mozambique, and Madagascar (mainly the western part).

Ecology: Primary forests up to 1800 m; in continental Africa especially on sandy river banks. *Fl.* mainly Oct.—Nov., *fr.* mainly Jan.—Febr. and May.

B. Subsp. **obtusifolium** (S. Elliot) Leenhouts, *nov. stat.* — *C. obtusifolium* S. Elliot — *C. boivinii* (*non* Engl.) Perrier de la Bâthie, 1944 and 1946, *l. c.*

Type: Madagascar, Fort Dauphin, *Scott Elliot 2933,* ♂ (K).

Evergreen tree. Leaves 2—4-jugate, the petiole, rhachis, and petiolules often minutely tomentose. Leaflets obovate to broadly elliptic, 4—8 by 2½—3½ cm, stiff-coriaceous, glabrous; base cuneate, rarely rounded to subcordate; margin entire; apex rounded to faintly acuminate; nervation strongly prominent beneath, nerves 7—12 pairs (angle 80—85°), straight to faintly curved, rather abruptly arching near the margin; veins usually transverse, rarely some intermediate ones well-developed; reticulations partly invisible. Inflorescences and flowers (♀ unknown) type 3. Infructescences and fruits type 5 and 2.

Distribution: Madagascar, mainly the eastern part.

Ecology: Primary forests up to 1800 m. *Fl.* Dec.—Jan., *fr.* the whole year, though possibly mainly in Sept.—Dec.

C. Subsp. **bullatum** Leenhouts, *nov. subsp.*

Foliola ovata ad lanceolata, 12—15 × 7—8 cm, subcoriacea, bullata, nervatione subtus breve pilosa; basis cordata; apex abrupte et breve obtuso-acuminata; nervatione subtus prominente, nervi utrimque 15—18, conspicue arcuatim conjuncti. Inflorescentiae (♂) late paniculatae, magnae, pauceramosae, tomentosae. Flores ♂ 5 mm longi, dense tomentosi.

Type: Madagascar, forêt d'Ambatosoratra, 8-1-1949, *Cours 3368*, ♂ (P).

Evergreen (?) tree. Leaves 4—6-jugate, the petiole, rhachis, and petiolules minutely tomentose. Leaflets subsessile, ovate to lanceolate, 12—20 by 6—10 cm, subcoriaceous, bullate, above glabrous except for the minutely tomentose midrib, beneath short hispidly pilose on the nerves; base cordate; apex rather abruptly acuminate, acumen up to 1 cm long, broad, and blunt; nervation sunken above, strongly prominent beneath, nerves 15—20 pairs (angle *c.* 75°), straight to faintly curved, gradually, distinctly arching; veins transverse, intermediate ones not strongly developed. Inflorescences and flowers (♀ unknown) type 2. Infructescences and fruits type 4.

Distribution: N.E. Madagascar, between 14 and 18° S.L.

Ecology: Forests up to 300 m. *Fl.* Jan., *fr.* Dec.

Note. This subspecies is in its vegetative parts rather different from the two other ones, and is not connected with them by intergrades (as are these two mutually), but since the differences in the flowers and fruits are only small, I deem it preferable for the time being to value it as a subspecies rather than as a species.

TANGANYIKA. *Holtz 1093* (a), *2490* (a). — Mafia isl.: *B.L. Institut Amani 5700* (a); *Greenway 5378* (a).

MOZAMBIQUE. *Godefroy-Lebeuf s.n.* (a).

MADAGASCAR. Western part: *Grevé 12* (syntype *C. multiflorum* Engl.) (a), *12a* (syntype *C. multiflorum* Engl.) (a), *74* (syntype *C. multiflorum* Engl.) (a); *Humbert 20369* (b); *Perrier de la Bâthie 605* (a), *787* (a), *787 bis*, *5853* (a), *5860* (a), *13833* (a); *Réserve National 11* (a), *31* (a), *1686* (b); *Scott Elliot 2933* (type *C. obtusifolium* S. Elliot) (b); *Service forestier 1550* (b), *2808* (a), *2845* (b), *3449* (a), *4122* (a), *4124* (a), *4444* (a), *5277* (a), *6093* (b), *6415* (b). — Eastern part: *d'Alleizette herb. 639* (aff. a), *in herb. L 951.54—176* (a); *Bernier 152 (= Chapelier 152)* (syntype *C. boivinii* Engl.) (a); *Boivin s.n.* (lectotype *C. boivinii* Engl.) (aff. a); *Cours 853* (b), *943* (b—a), *3368* (type *C. madagascariense ssp. bullatum* Leenh.) (c); *Decary 15273* (a); *Geay 7058* (b); *Humbert 22809* (paratype *C. madagascariense ssp. bullatum* Leenh.) (c); *Lam & Meeuse 6000* (aff. b); *Louvel 144* (aff. a); *Perrier de la Bâthie 5868* (a), *5869* (a—b), *5880* (a—b), *5881* (aff. a), *5884* (b—a), *6401* (a—b), *6402* (aff. b), *14013* (b), *14217* (b), *15481*, *18408* (aff. a); *Réserve National 1288* (a), *1950* (a—b), *2628* (b), *2851* (a), *4895* (a); *Richard 340* (type) (a); *Service forestier 684* (aff. b), *854* (b), *980* (a—b), *1125* (b), *1368* (a—b), *1902* (a), *2087* (b—a), *2088* (aff. b), *2089* (b—a), *2388* (b), *2389* (paratype *C. madagascariense ssp. bullatum* Leenh.) (c), *2570* (aff. c), *2639* (aff. b), *2660* (aff. b), *2994* (aff. b), *3329* (a—b), *3661* (aff. b), *3739* (aff. b), *4650* (aff. b), *4713* (b), *5119* (b), *5228* (b), *5594* (aff. b), *6112* (a), *6419* (paratype *C. madagascariense ssp. bullatum* Leenh.) (c); *Thouvenot 70* (aff. b), *137* (b); *Ursch 70* (b), *197* (a), *209* (b), *222* (a). — Exact locality unknown: *Cours 2643* (b); *Homolle 2643* (a—b); *Service forestier 4486* (aff. a), *5020* (a); *Vaillant herb. 97* (b).

Wood anat.: See H. Lecomte, 1922, *l. c.*, t. 24.

Uses. The timber is resistant to sea-water, and therefore used for making canoes; furthermore for construction. The resin is used for many purposes; it is white and clear; it is used for caulking boats, it is burned as an incense, and it is in use as a medicine (*"contre affections des voies urinaires"*). The fruits and especially the seeds are eaten.

28. Canarium schweinfurthii Engler, 1883, 145; 1892, 99; Warburg, 1895, 199; Gilg, 1895, 312 & 412; Harms, 1895, 474; Guillaumin, 1908b, 266; Durand, 1909, 90; Guillaumin, 1909a, 238 f. $22^{25, 26}$; 1909c (1), 493, (2), 45; 1911a, 34; Engler, 1915, 780, f. 367; De Wildeman, 1916, 281; 1920, 167; Exell, 1927, 59; Vermoesen, 1931, 39—40; Hill, 1933, 879 f. 6; Aubréville, 1936, 107, t. 170; Dalziel, 1937, 315; Brenan & Greenway, 1949, 78; Troupin, 1950, 123; Exell & Mendonça, 1951, 305. — *C. chevalieri* Guillaumin, 1908a, 33. — *C. thollonicum* Guillaumin, 1908b, 266; 1909a, 238—239, f. 22^{23}, 23^{11}; 1911a, 35. — *C. velutinum* Guillaumin, 1908b, 267. — *Aucoumea ? velutina* Pierre *ex* Guillaumin, 1908b, 267, *nom. nud.* — *C. occidentale* Chevalier, 1909, 145; Guillaumin, 1909a, 238 f. 22^{24}, 27; 1910a, 454 f. 13; 1911a, 31. — *Boswellia occidentalis* Chevalier *ex* Guillaumin, 1911a, 32, *nom. nud.* — *Bersama zenkeri* Gürke *ex* Chevalier, 1920, 110, *nom. nud.* — *C. khiala* Chevalier, 1920, 110, *nom. nud.* — *Fig. 20.*

Type: Sudan-Belgian Congo, Niam Niam, Juru River, 11-5-1870, *Schweinfurth 3324*, y. fr. (K; isotype in P).

Deciduous tree, up to 50 m high, up to about 2 m in diam., without or with small buttresses. *Branchlets* 1—2 cm thick, subglabrous with the exception of the fulvous-tomentose terminal bud; pith with many small vascular strands, which are arranged in a double peripheral cylinder. *Stipules*, together with the broadened basal part of the petiole, enclosing the terminal bud, caducous, inserted on the petiole at 1½—5 cm from its base, oblong spathulate, *c.* 3½ by ½ cm, acute, thin-herbaceous, sparsely fulvous-tomentose, provided with a distinct median nerve. *Leaves* 8—12-jugate, up to 110 cm long. *Petioles* flattened and winged up to the stipule (scar)s, rather densely pilose as are the rhachides and petiolules. *Leaflets* shortly stalked, (ovate to) oblong, basal ones ovate and smaller, terminal one elliptic, 9—20 by 3—5½ cm, rather stiff chartaceous, minutely tomentose on the midrib above, scattered pilose on the nerves beneath; base sometimes slightly oblique, (rounded to) cordate; margin entire; apex acute, gradually to abruptly acuminate, acumen 1—1½ cm long, blunt to acute; nerves (15—)20—24 pairs (angle 65—90°, rather variable), straight to slightly curved or sinuate, sometimes slightly winding (probably these are strongly developed intermediate veins), rather abruptly bent near the margin, not distinctly arching. *Inflorescences* axillary, narrowly thyrsoid to subracemose (♀), minutely pubescent, more or less glabrescent, ♂ ones 20—30 cm long, many-flowered, ♀ ones 15—25 cm, with few flowers; ♂ flowers in short-stalked glomerules, ♀ ones 2—1 on a short branch; bracts ♂ ovate, acute, up to 15 by 8 mm, ♀ broadly ovate, 7 by 6 mm. *Flowers* densely minutely tomentose, ♂ 10 mm long, ♀ 12 mm, with a hollowed receptacle. *Calyx* in ♂ flowers 6 mm, the sepals connate for 1—2 mm, exduplicative-valvate; in ♀ flowers 7—8 mm, the sepals halfway connate. *Stamens* 6, in ♂ flowers glabrous, adnate to the disk in such a way, that apparently they are inserted on an androphore; in ♀ flowers inserted on the disk, with some bristles on the thecas. *Disk* in ♂ flowers slender obconical, 1—2 mm high, minutely pubescent, with a narrow central canal, usually without, sometimes with a free, slender, 1—1½ mm high pistil, this sometimes even with cells and ovules (*J. Louis 2162:* solid ovariodisk with style-remnant); in ♀ flowers tubular, (1—)3½ mm high, faintly 6-lobed, glabrous, forming the 'staminal

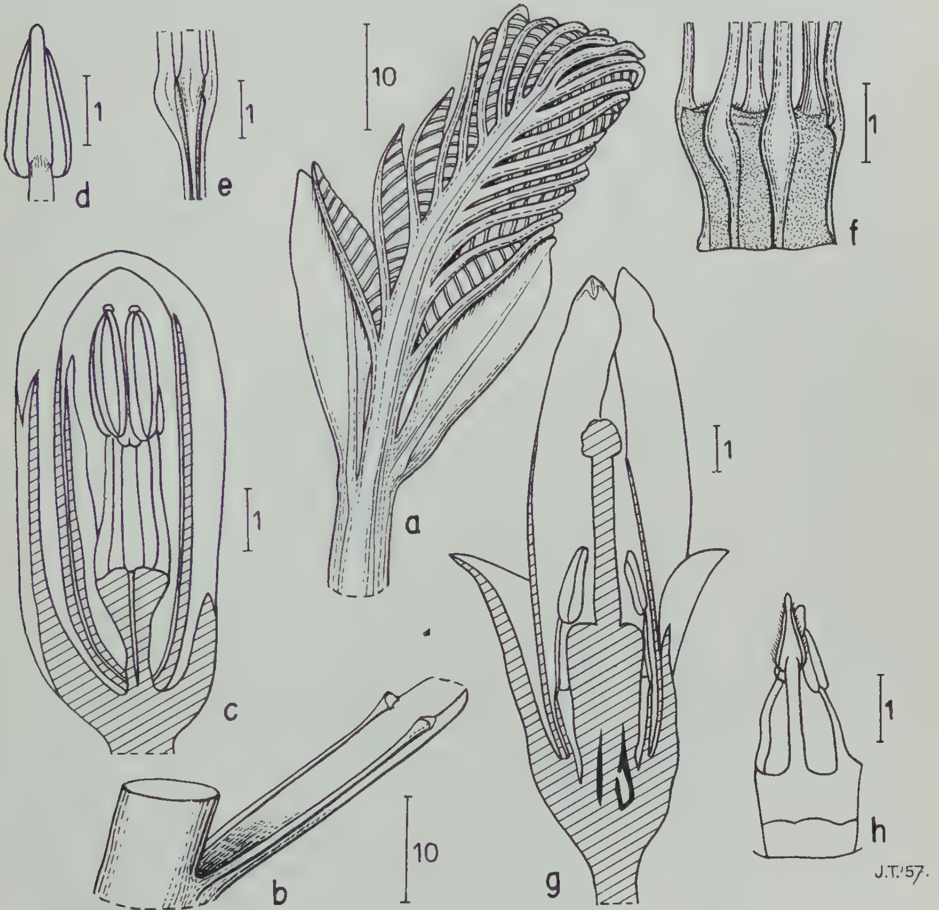


Fig. 20. *C. schweinfurthii* — a. young leaf with stipules; b. base of the petiole with stipule-scars; c. longitudinal section of ♂ flower; d. anther from the back; e. and f. disk with adnate bases of stamens in ♂ flowers; g. longitudinal section of ♀ flower; h. disk and stamens in ♀ flower. (a—b. from *Chevalier 8654;* c—e. from *Staudt 507;* f. from *Donis 2425;* g—h. from *Zenker 2481*) (dimensions in mm).

tube' (or only the thicker basal part of it?). *Pistil* glabrous. *Infructescences* subracemose (to thyrsoid), usually 20—30 cm long, coarse, with up to 5 (rarely more) fruits; calyx saucer-shaped, triangular to faintly 3-lobed, c. 1½ cm in diam. *Fruits* ellipsoid to obovoid, round in cross-section, 34—37 by 17—20 mm, glabrous; pyrene pear-shaped, triangular at the base, rounded triangular in cross-section, acutely 6-ribbed near the apex; lids c. 3 mm thick. *Seeds* 1(—2); sterile cells moderately reduced.

Distribution: tropical West and Central Africa.

Portuguese Guinea. *Espirito Santo 1889.*

French West Africa. French Guinea: *Chevalier 20989.* — Upper Volta: *Vuillet 560, 561, 561b.*

Sierra Leone. *Dawe 549; Deighton 4738; H. C. King 183; Lane-Poole 190.*

Liberia. *Cooper 125, 192, 385.*

Ivory Coast. *Aubréville 21, 2257; Chevalier 15272* (syntype *C. chevalieri* Guill.), *15385* (syntype *C. chevalieri* Guill.), *16236* (type *C. occidentale* Chev.), *19244, 19392, 20066, 22112, 22288; Fleury 14, 80.*

Gold Coast. *Irvine 2237.*

Togo. *Mildbread 7278.*

Nigeria. Northern provinces: *Lamb 43; Lehr P 4; Yates 21.* — Western provinces: *Brenan & Richards 8430; Kennedy 503; Thompson 17.* — Eastern provinces: *King-Churce 42; Talbot 3323.* — South Nigeria: *Foster 204; Kennedy 1665; Unwin 19.*

Cameroons. *Annet 447; Aubréville 692; Fleury 21 (= herb. Chevalier 33470); Foury 61, 65; Hedin 284, 740, 1011, 1049, 1577, 1653, Ds. 13; Jacques-Félix 2946; Mildbread 7799, 8821, 9719; Staudt 507; Zenker 512, 2481, 2930.*

Ubangi-Shari. *d'Alleizette in herb. L 951.54—169 & 173; Le Testu 2542; Thollon 19* (type *C. thollonicum* Guill.); *Tisserant 1012, 1443, 2396.*

Sudan. Equatorial prov.: *Andrews A 1481; Cartwright 1; Turner 156; Wyld 74.*

Ethiopia. Acc. to Exell & Mendonça, *l. c.*

Gabon. *Klaine 1326* (type *C. velutinum* Guill.); *Le Testu 1736, 5439, 7282.*

French Congo. *Sargos 84.*

Belgian Congo. Equatorial prov.: *Corbisier 805; Corbisier Baland 1798; Coûteaux 136; Dubois 674; de Giorgi 114, 229; Leemans 634; Louis 2162.* — Oriental prov.: *van den Brand 539; Germain 4499; Gilbert 1183, 1210; de Graer 266; Louis 438, 549, 1200, 1396, 2296, 3199, 3298, 6572, 8651, 9020, 11452, 13710, 14351; v. d. Meiren 83; Micha 24; Schweinfurth 3324* (type); *Troupin 499, 1730.* — Leopoldville prov.: *Donis 417, 2425; Ghesquière 14; Service forestier 29 (Cauwe), 53 (Cauwe); Toussaint 169, 2326; Vermoesen 1325, 1436, 1582, 1839, 1890, 2632.* — Kasai prov.: *Claessens 156, 381; Hardy 40; Joseph D 7a; Vanderyst 9277, 10425.* — Katanga prov.: *Delvaux 68, 200; Herman 2128; Hoffmann 828; Mullenders 1441.* — without locality: *Claessens 120, 446; Flamigny 7004, 9004; Gilbert 720, 1061; Goossens 2953; Jespersen 15; Lacomblez 84; De Wevre 891.*

Uganda. *Bagshawe 111; Dümmer 1359; Eggeling 79 (= Braznett 252); Scott Elliot 7167, 7502.*

Tanganyika. *Gillman 468; Wigg 322.*

Angola. *Carrisso & Mendonça 22, 165; Gossweiler 8, 6565, 6891, 7042, 7074, 7084, 7089, 9170, 9351 (= 9357 ?).*

cultivated:

Ubangi-Shari. *Chevalier 8654.*

Tanganyika. *Greenway 3372.*

Angola. *Gossweiler 9357.*

Ecology: In primary rain-forests or, in drier regions, in the riverain forests; sometimes in periodically inundated places. Altitude up to 750(—1300) m. The leaves are falling at the end of the dry period (Jan.—Febr.). *Fl.* (Sept.—)Jan.—June(—July), *fr.* (Jan.—)Febr.—May(—Dec.).

Wood anat.: See Bertin, Les Bois du Cameroun, 1920, 137; Dalziel, 1937, *l. c.*; Jay, Timbers of W. Africa, ed. 3, 1950, 25; Fouarge *et all.*, Bois du Congo, 1953, 207, t. 20.

Uses. The timber is used by the natives for building canoes, by the Europeans for furniture; moreover it seems suitable for the manufacture of plywood, soft board, and paper. Decoction of the bark is used as a medicine against dysentery. The resin (*élémi africain*) is used by the natives for lighting and torches, for caulking canoes, gluing pottery, stiffening fishing-lines, and as a medicine, moreover natives sometimes oil their body with it, whether or not mixed up with clay, and by burning it they drive the mosquitoes out of their cabins; the missionaries use it as incense; on the European market it is in use for plasters, printing-ink, and varnish. (Analysis: Dunstan, Bull. Imp. Inst. London 6, 1908, 252). The fruits (apparently the pulp as well as the seeds) are eaten, usually after boiling. An edible oil is pressed out of the seeds. The nuts are used for carving and as a decoration.

Morphology: Some specimens, apparently in particular those from a higher altitude (e. g. *Jacques-Félix 2946*) are very coarse and hairy.

Taxonomy: Apparently, the present species is not closely allied to any other species of the genus; to all probability it has been isolated for a very long time. Unique are especially the strongly elongated stipules, and is the pseudo-androphore consisting of the elongated, tube-like disk, to which the stamens are entirely adnate.

29. Canarium pseudopatentinervium H. J. Lam, 1932a, 214, t. 13 f. 104e; 1932b, 490, t. 12 f. 77; Leenhouts, 1956, 274, f. 2h.

Type: Sumatra, Palembang, Lematang Ilir near G. Megang, alt. 75 m, April 14, 1923, *FRI. 153 T3P. 336*, ♀, lectotype (BO).

Tree 20—38 m by 20—60 cm. *Branchlets* c. ¾ cm diam., glabrescent; pith with many peripherally arranged small vascular strands and often with a central cavity. *Stipules* none. *Leaves* 1—2(—4)-jugate, glabrescent. *Leaflets* ovate to elliptic, rarely oblong, 5—12½ by 2¼—7 cm, rigid, (sub)-glabrous; base rounded (to broadly cuneate); margin entire; apex short-blunt-acuminate; nerves 7—14 pairs (angle 70—80°), faintly curved, not distinctly arching. *Inflorescences* (♂ unknown) terminal, thyrsoid, 8—15 cm long, densely tomentose, main branches up to 4 cm, racemose, with 10—15 flowers. *Bracts* subulate. *Flowers* (♂ unknown) subsessile, densely tomentose, buds 7 mm long. *Petals* distinctly unguiculate, apex incrassate-inflexed. *Stamens* free, glabrous. *Disk* adnate to the slightly concave receptacle, free rim 1 mm high, 6-lobed, the whole disk except for the outer base of the rim long-pilose. *Pistil* densely pubescent. *Infructescences* c. 7 cm long, with 1 fruit; calyx flat, 3-lobed, c. 2 cm diam. *Fruits* ellipsoid, circular to rounded-triangular in cross-section, 5—7 by 2—3 cm, glabrous; pyrene truncate-triangular in cross-section with hollow sides, smooth or with a faint median rib on the lids, acutely angular and acute at both ends; lids 3—4 mm thick. *Seeds* 1(—2); sterile cells moderately reduced.

Distribution: South Sumatra, Banka, Borneo.

SUMATRA. *Forbes 3037; FRI. T3P 577* (syntype), *153 T3P 336* (lectotype).

BORNEO. *FRI. bb. 10529* (syntype), *bb. 10849 (v. d. Zwaan 101)* (syntype), *bb. 18468 (v. d. Zwaan 720), bb. 27758.*

Ecology: Primary forests, up to 700 m. *Fl.* March—April, *fr.* July and Oct.

Note. Closely related to *C. apertum* and to *C. grandifolium,* the only other species with unguiculate petals.

30. **Canarium grandifolium** (Ridl.) H. J. Lam, 1932a, 215; 1932b, 527; Leenhouts, 1956, 275, f. 20a. — *Trigonochlamys grandifolia* Ridley, 1909, 31; 1922, 381. — *Fig. 21.*

Type: Malay Peninsula, Singapore, *Cantley's coll. s.n.,* ♀, lectotype (SING).

Tree 35 m by 60 cm. *Branchlets* ½—¾ cm diam., densely fulvous-tomentose when young; pith dark-brown, hard, with peripherally arranged small vascular strands. *Stipules* none. *Leaves* 2—3-jugate, 25—40 cm long. *Leaflets* elliptic, 10—17 by 5—8 cm, stiff-chartaceous to coriaceous, densely tomentose beneath and on the midrib above, nervation prominent beneath; base slightly oblique, broadly cuneate to rounded; margin revolute, minutely fimbriate-serrate to entire; apex rather abruptly short-acute-acuminate; nerves 10—14 pairs (angle 65—75°), faintly curved, sometimes arching close to the margin. *Inflorescences* terminal, densely ferruginously tomentose, ♂ thyrsoid, *c.* 18 cm long, flowers clustered, ♀ racemose to spicate, 6—10 cm long, with *c.* 12—15 flowers. *Bracts* subulate. *Flowers* pubescent, ♂ 13 mm, ♀ 15 mm with a slightly concave receptacle. *Calyx* ♂ 11 mm, ♀ 15 mm. *Petals* unguiculate, apex inflexed-acuminate, incrassate. *Stamens* free, glabrous. *Disk* ♂ cupular, 1 mm high, densely erect-pilose, ♀ densely pubescent, adnate to the receptacle, free rim 1 mm. *Pistil* not stalked, densely woolly pubescent; ♂ none. *Infructescences* and *fruits* unknown.

Distribution: Malay Peninsula (Johore, Singapore), apparently rare.

MALAY PENINSULA. *Cantley's coll. s.n.* (lectotype *Trigonochlamys grandifolia* Ridl.); *KEP. 70139; Ridley 10735* (syntype *Trigonochlamys grandifolia* Ridl.).

Ecology: *Fl.* Febr.

Note. Closely related to *C. apertum.*

31. **Canarium apertum** H. J. Lam, 1932a, 214, t. 5 f. 6; 1932b, 491, t. 12 f. 78; Buckley, 1932, 36; Wyatt-Smith, 1953, 8, *cum fig.;* Leenhouts, 1956, 275. — *Santiria serrulata* Engler, 1883, 160, *non C. serrulatum* Miquel, 1859.

Type: *Santiria serrulata* Engl.: Borneo, Sarawak, Mattang, May 1886, *Beccari PB. 1630,* ♂ (K; isotype in FI).

Tree 25—30(—45) m by 40—120 cm, buttressed. *Branchlets* ½—¾ cm diam., sparsely tomentose or glabrescent; pith dark-brown, hard, with a peripheral sclerenchymatic cylinder (vascular strands usually invisible). *Stipules* none. *Leaves* 2—7-jugate. *Leaflets* oblong-elliptic to ovate, 4—13(—15½) by 2—5(—9) cm, rigid, subcoriaceous, subglabrous to more or less pubescent, specially on the prominent nerves beneath; base nearly equilateral, rounded to subcordate; margin often revolute, fimbriate, serrate (rarely dentate or repandous) to entire; apex acute to rounded, rarely emarginate; nerves 11—16(—18) pairs (angle *c.* 65°), straight or more or less irregularly curved, sometimes arching close to the margin. *Inflorescences* (♀ unknown)

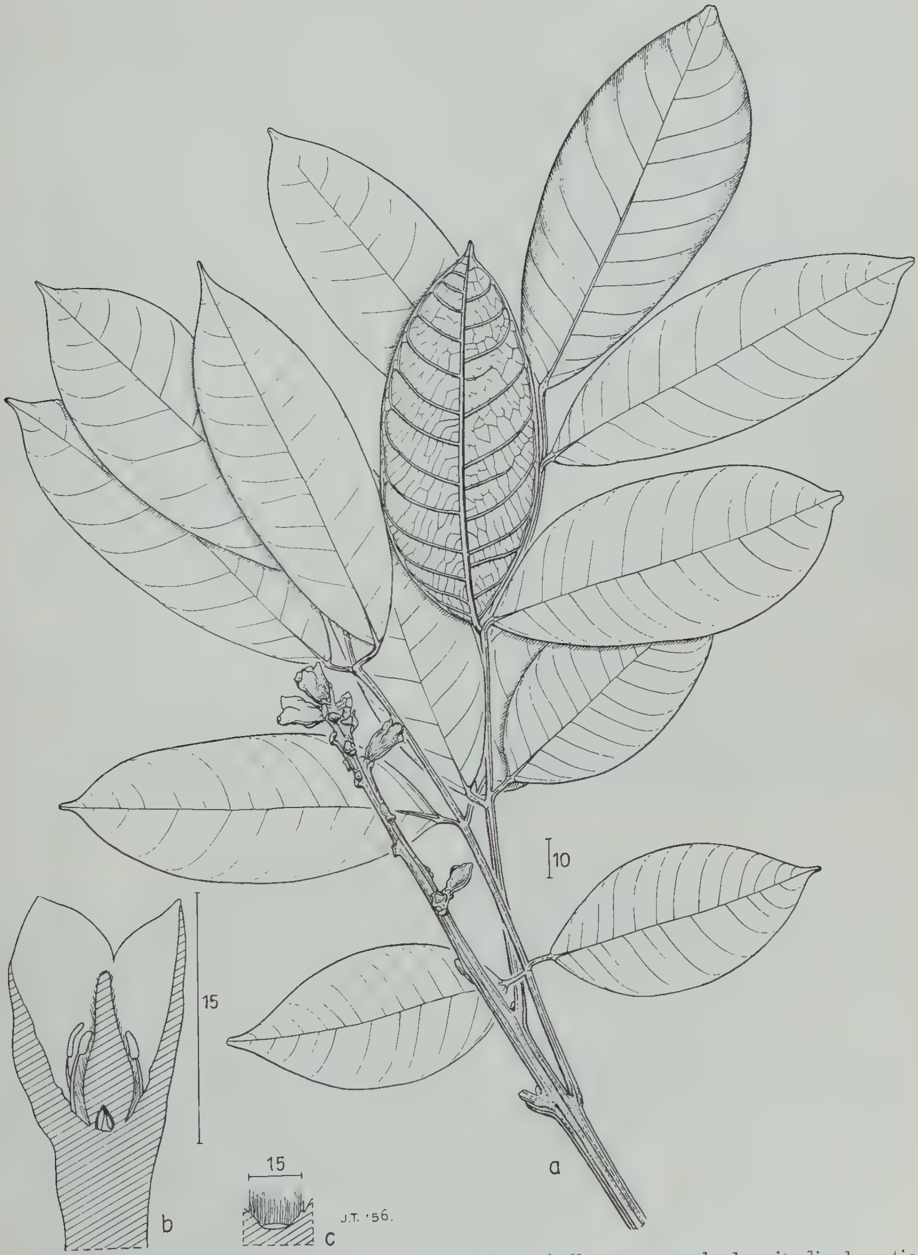


Fig. 21. *C. grandifolium* — a. twig with ♀ inflorescence; b. longitudinal section of old ♀ flower; c. ditto, longitudinal section of the disk. (*Cantley's coll. s.n.*) (dimensions in mm).

terminal, broadly thyrsoid, 10—30 cm long, densely rusty pubescent, main branches up to 13½ cm, broadly paniculate, many-flowered. *Bracts* subulate. *Flowers* (♀ unknown) *c.* 1 cm long, pubescent. *Calyx* 8—9 mm. *Petals* unguiculate, apex inflexed-acuminate, incrassate. *Stamens* free, glabrous. *Disk* cup-shaped, 1 mm high, densely erect-pilose. *Pistil* none. *Infructescences* terminal and sometimes in the upper leaf-axils, 6—8 cm long, rusty tomentose to glabrous, with 1 fruit; calyx saucer-shaped to cupular, deeply 3-lobed, 12—15 mm diam., with the remains of 6 stamens and 1—2 mm high, faintly 6-lobed, rusty long-pilose disk. *Fruits* ovoid, acuminate, circular in cross-section, 4—5 by 2—2¾ cm, fulvously tomentose, specially near the base and apex; pyrene rounded in cross-section, angle-ribs blunt, lids with a faint median rib each; lids up to 7 mm thick, very hard. *Seeds* 1(—2); sterile cells nearly invisible.

Distribution: Sumatra, Malay Peninsula, Borneo.

SUMATRA. *FRI. bb. 26395, bb. 27513 (Buwalda 94), bb. 28617 (Buwalda 394).*
MALAY PENINSULA. *KEP. 1147 (Foxworthy), 10689 (Hamid), 18427, 18506 (Foston), 38181 (Klang); SF. 28437 (Corner).*
BORNEO. *Beccari PB. 1630* (type *Santiria serrulata* Engl.); *FRI. bb. 10534, bb. 11202, bb. 16796, bb. 16827, bb. 21159 (v. d. Zwaan 37), bb. 26062, bb. 28377, bb. 29677, bb. 29710; Kostermans 8956; NBFD. SAN 15239 (Wood).*

Ecology: Primary forests up to 200(—500) m. *Fl.* Febr. (Mal. Pen.), May—June (Borneo), *fr.* May (Mal. Pen.), Aug. & Dec. (Borneo), Nov. (Sum.).

Wood anat.: Desch, Mal. For. Rec. 15^1 (1941) 63 (hand lens).

Notes. Closely related to *C. grandifolium* and also to *C. pseudopatentinervium.*

It is very remarkable, that two out of these three species were at first described as *Santiria* (*incl.* also *Trigonochlamys*). Yet the fruit- and flower-characters are typically those of *Canarium.*

Incertae sedis

Sect. *Regressiva* subsect. *Foliosa* H. J. Lam, 1932a, 209.

The relationship of the next 2 *spp.,* which are mutually closely related, is uncertain. In fertile characters they are close to sect. *Canarium,* in vegetative characters they remind of some species of sect. *Pimela,* specially of *C. australianum.*

32. **Canarium pseudodecumanum** Hochreutiner, 1904, 61; 1905, 88; 1910, 851; Heyne, 1927, 878; Lam, 1932a, t. 13 f. 104a; 1932b, 438, t. 9 f. 51; Wyatt-Smith, 1953, 6, *cum fig.*; Leenhouts, 1956, 275. — *Canariopsis decumana* (*non* Bl.) Miquel, 1861, 206, 527. — *Canarium decumanum* (*non* Gaertn.) Engler, 1883, 132; Lam, 1929, 116.

Type: Sumatra, Lampong, *Hort. Bot. Bog. VI E 6a,* st. (BO; isotypes in BR, BRSL, G, K, L, NY, P).

Tree up to 50 m by 165 cm, with large buttresses. *Branchlets* (¾—)1½—2½ cm diam., angular, glabrescent, leaf-scars large, terminal bud slender, 3—5 cm by 7—9 mm, densely ferruginously woolly pubescent; pith thick, with many small vascular strands, appressed to the thin wood-cylinder. *Stipules* none. *Leaves* often nearly in whorls of four, (3—)4—6-

jugate. *Leaflets* nearly sessile, lanceolate to oblong, 5—28(—33) by (2—)3—10(—12) cm, subcoriaceous, subglabrous above, densely minutely tomentose to sparsely stellately pubescent or nearly glabrous beneath; base rounded to subcordate; margin minutely serrulate (to subentire); apex rather abruptly, shortly acute-acuminate; nerves 20—25 pairs (angle variable), tortuous, more or less distinctly arching towards the margin, prominent beneath; reticulations very dense, waffle-like beneath. *Inflorescences* (♀ unknown) axillary, narrowly thyrsoid, up to 16 cm long, many-flowered, tomentose; flowers in glomerules. *Bracts* lanceolate to subulate. *Flowers* (♀ unknown) 7—9 mm long, pubescent. *Calyx* 3½ mm high. *Stamens* free, glabrous. *Disk* cupular, 2 mm high, fleshy, densely erectly pilose. *Pistil* none. *Infructescences* unknown; calyx with remnants of a 6-lobed, fimbriate disk. *Fruits* ellipsoid, subtrigonous in cross-section, 7—8½ by 4½—6 cm, densely tomentose when young, glabrescent, scurfy; pyrene smooth, with 3 angle-ribs near the apex and often a faint median rib on each of the lids; lids 4—5 mm thick. *Seeds* (3—)2—1; all cells irregular-shaped, sterile ones slightly or not reduced.

Distribution: Sumatra, Malay Peninsula, Borneo.

SUMATRA. *Dumas 1667; FRI. bb. 4878, bb. 27045, bb. 33025 (Soegihan 4); Hort. Bot. Bog. VI E 6a* (type); *Teysmann in herb. U 032918.*

MALAY PENINSULA. *KEP. 10885 (Hamid), 11452 (Meh), 12208 (Abdullah), 13451, 43563 (Symington), 46052 (Ja'amat); Kerr 15839.*

BORNEO. *Elmer 21253; FRI. bb. 12431, bb. 13666, bb. 19984 (Henar 3).*

Ecology: Primary forests, up to 280 m. *Fl.* Apr. (Mal. Pen.), Oct. (Borneo), *fr.* March and Aug.—Nov. (Sum.).

Uses. The wood is very soft. The abundant resin is used for caulking canoes. An edible oil is pressed out of the seeds, which also are eaten.

Notes. Closely related to *C. decumanum*, different from the latter by the absence of stipules and by the serrate leaflets. The two species are nearly vicariads, even in Borneo.

33. Canarium decumanum (Rumphius, 1741, 166, t. 55) Gaertner, 1791, 99, t. 102; Willdenow, 1805, 760; De Candolle, 1825, 80; Roemer & Schultes, 1829, 80; *non* Engler, 1883, 132 (= *C. pseudodecumanum* Hochr.); Koorders & Valeton, 1896, 48, 313; 1897, t. 8; Guillaumin, 1909a, f. 22[13], 23[5]; Backer, 1911, 198, *excl. specim. sumatr.;* Koorders, 1912, 434; Senn, 1912, t. 22; Koorders, 1913, t. 150; Merrill, 1917, 300; Heyne, 1927, 876; *non* H. J. Lam, 1929, 116 (= *C. pseudodecumanum* Hochr.); H. J. Lam, 1931—1932a, t. 6 f. 24—44, f. 52, t. 15 f. 115a; 1932b, 435; Hildebrand, 1934, 267; H. J. Lam, 1948, 5; Leenhouts, 1956, 276, f. 22a, 39 & 40. — *Pimela decumana* Blume, 1850, 223. — *Canariopsis decumana* Blume *ex* Miquel, 1859, 652; *non* Miquel, 1861, 206, 527 (= *C. pseudodecumanum* Hochr.).

Type: Moluccas, *Hort. Bot. Bog. VI E 5* (= *Pl. Bog. Exsicc. 116*), fr., neotype (L; isotypes in B, BO, BRSL, G, K, L, NY).

Tree, 30—60 by 1½—2 m, with very large buttresses (up to 8 m high and 5 m wide). *Branchlets* 1—1½ cm diam., angular, glabrescent, with large leaf-scars, terminal bud slender, acute, 4—5 cm by 6 mm, densely brown-tomentose; pith thick with many peripherally arranged small vascular strands. *Stipules* represented by the basal pair of leaflets, which are rather caducous — leaving a small circular scar —, inserted at the conjunction of branch and petiole and very small (petiolule 4—10 mm, blade 1½—2½ by ¾—2 cm). *Leaves* spirally arranged, (3—)4—5(—6)-jugate, 35—45 cm long. *Leaflets* ovate to oblong, 5—10—30 by 2½—5—10 cm, stiff-chartaceous to coriaceous, glabrescent; base rounded to subcordate; margin entire; apex gradually long and acutely acuminate; nerves 17—22—26 pairs (angle *c.* 60°), tortuous, towards the margin dissolving into a lax marginal reticulation, rather prominent beneath, some of the nerves more or less reduced (similar to intermediate veins); reticulations dense. *Inflorescences* axillary, narrowly thyrsoid, densely minutely tomentose, ♂ 4—19 cm long, many-flowered, main branches up to 6½ cm, flowers clustered; ♀ 5—7 cm, few-flowered, main branches very short. *Bracts* lanceolate to subulate. *Flowers* pubescent, ♂ 7—9 mm, ♀ 8—14 mm. *Calyx* ♂ 3½ mm high, ♀ 4½—7 mm. *Stamens* free, glabrous. *Disk* ♂ cushion-shaped, 2 mm high, faintly 6-lobed, densely pilose; ♀ 6-lobed, 1 mm high, fimbriate. *Pistil* pubescent, ♂ none. *Infructescences* subracemose, with few fruits; calyx flat, 1 cm diam. *Fruits* ellipsoid, subtrigonous in cross-section, 7—8½ by 4½—6 cm, glabrescent, scabrous; pyrene smooth except of 3 angle-ribs near the apex and a faint median rib on each of the lids; lids 4—5 mm thick. *Seeds* (3—)2—1; cells irregularly shaped, sterile ones not or slightly reduced.

Distribution: East Borneo, Moluccas (Morotai, Ternate, Batjan, Ceram), New Guinea (Vogelkop). According to Rumphius (*l. c.*), also in South Celebes, Buton, Halmaheira, the Sula Islands, and Buru. Not rarely cultivated, especially in Java.

BORNEO. *FRI. bb. 10155, bb. 26371; Kostermans 6956; NBFD. SAN 16109 (Wood).*

MOLUCCAS. Morotai: *FRI. bb. 33893 (Tangkilisan 220), bb. 33903 (Tangkilisan 233); Lam 3637.* — Ternate: *Beccari herb. 2168.* — Ceram: *FRI. bb. 25864 (Buwalda 519).*

NEW GUINEA. Vogelkop: *Beccari PP 735; BW. 2626 (Brouwer).*

cultivated:

JAVA. *Bakhuizen v. d. Brink Jr. 3661; Hort. Bot. Bog. VI E 5* (neotype), *VI E 5a; Koorders 22422 β, 40350 β.*

Ecology: Primary forests at low altitudes. *Fl.* April—May, *fr.* June—Nov.

Uses. The resin and the seeds are used, but they are of no great importance.

Notes. Closely related to *C. pseudodecumanum;* different from the latter by the stipules and the entire leaflets.

Young specimens very much resemble *Flindersia schottiana* F. Muell. (*Rutac.*), which however can easily be recognized by the presence of distinct pellucid oil-glands in the leaflets.

II. SECTION PIMELA

DC. Prod. 2 (1825) 80. — *Pimela* Lour. Fl. Coch. (1790) 407. — Sect. *Regressiva* subsect. *Subulata* H. J. Lam, Ann. Jard. Bot. Btzg 42 (1932) 209.

Stipules subulate to lanceolate, not rarely absent; scars orbicular, minute. *Bracts* deltoid to subulate, not consisting of connate stipules. *Leaflets* greyish-green when dry; margin entire to serrate; indument, if present, mostly consisting of hispid hairs. *Inflorescences* mostly axillary to pseudo-terminal, very rarely terminal. *Stamens* often partly to entirely connate, rarely adnate to the disk. *Receptacle* in ♀ flowers nearly always flat, very rarely slightly concave. *Disk* usually 6-lobed, often pilose. *Pistil* very rarely stalked, mostly pilose. *Calyx* in fruit rarely more than 1 cm diam., outside usually glabrous, inside mostly sericeous, flat, lobes often reflexed. *Fruits* small, 2½—3½(—5) cm long; pyrene often with angle- and median ribs, sometimes entirely tuberculate.

Distribution: Continental S.E. Asia from S. Deccan to S. China and Hainan, Andamans and Nicobars, Malaysia, Carolines, New Britain, N. Queensland, Solomon Isl., New Hebrides, Fiji, Samoa, and Tonga.

34. Canarium oleosum (Lamk) Engler, 1896, 241, f. 136 Q—S; Guillaumin, 1909a, 246, f. 8, 18, 22^5, $23^{12, 13}$, 25, 26 P, 30; 1910, 454, f. 2, t. 12 f. 2; Merrill, 1917, 303; Heyne, 1927, 878; Lam 1932a, t. 12 f. 91, t. 13 f. 100—101; 1932b, 483, t. 11 f. 74; Meyer Drees, 1951, 43; Leenhouts, 1956, 278, f. 20b, 21 l, & 41. — *Nanarium minimum sive oleosum* Rumphius, 1741, 162, t. 54. — *Amyris oleosa* Lamarck, 1783, 362. — *C. microcarpum* Willdenow, 1806, 760; Poiret, 1811, 72; Miquel, 1859, 646; Engler, 1883, 125; Vorderman, 1894, 111; Hochreutiner, 1905, 90, *incl. f. minor;* Boorsma, 1907, 29. — *C. laxiflorum* Decaisne, 1834, 477; Spanoghe, 1841, 188. — *C. pimela* (*non* Koen.) Spanoghe, 1835, 346.

Type: Lesser Sunda Islands, Timor, (*Riedlé & Guichenot s.n.),* ♀ & fr., neotype (P; isotypes in G, K, NY).

Tree 17—20(—30) m by 25—50 cm; sometimes buttressed. Branchlets ¼—½ cm thick, soon glabrescent; pith with a peripheral cylinder of vascular strands. *Stipules* none. *Leaves* (0—)3—5(—7)-jugate, glabrous. *Leaflets* ovate to lanceolate, 2—18 by 1—7 cm, thin-chartaceous; base slightly oblique, cuneate to rounded; margin entire; apex gradually narrowed into a short, broad, and blunt acumen; nerves 10—15 pairs (angle 60—80°), straight to slightly curved, rather abruptly and conspicuously arching at some distance from the margin; intermediate veins strongly developed; reticulations lax. *Inflorescences* axillary, slender, narrowly and laxly thyrsoid, (4—)30—45 cm, glabrous; branches patent but for the longer basal ones, up to 4½ cm (♂ ones sometimes up to 10 cm), long-stalked, ♂ ones many-flowered, ♀ ones up to 5-flowered. *Flowers* 5—7 mm long, glabrous, ♀ ones sometimes with a slightly concave receptacle. *Calyx* 2—3 mm high. *Stamens* glabrous, in ♂ flowers slightly connate at the base, in ♀ flowers free. *Disk* in ♂ flowers pistilloid, ovoid, sometimes shortly stalked, 1½ mm high, pilose at the apex, tapering into a short, style-like appendix; in ♀ flowers cupular, 6-undulate, 1 mm high, fimbriate. *Pistil* glabrous (very rarely tomentose). *Infructescences* slender, with up to 5 fruits; calyx flat, triangular, 3½—5 mm diam., with reflexed lobes. *Fruits* ovoid to obovoid, round in cross-section, 1¼—2 by ¾—1¼ cm, glabrous; pyrene faintly 6-ribbed, sometimes slightly rugose; lids 2 mm thick. *Seed* 1; sterile cells nearly obsolete.

Distribution: Lesser Sunda Islands (Alor, Timor, Wetar), N. Celebes, Moluccas (Morotai, Ternate, Batjan, Obi, Buru, Kai Islands), New Guinea, and New Britain.

LESSER SUNDA ISLANDS. Timor: *(Riedlé & Guichenot s.n.)* (type *C. laxiflorum* Decne) (neotype *Amyris oleosa* Lamk). — Wetar: *FRI. bb. 27191.*

MOLUCCAS. Morotai: *Main & Aden 1425.* — Batjan: *Beccari herb. 2188.* — Obi: *Atasrip 113, 122.* — Buru: *Beccari herb. 2187; Hort. Bot Bog. VI B 27a; Teysmann 53.* — Kai Islands: *Beccari herb. 2186, herb. 2189; Jaheri 475.*

NEW GUINEA. *Beccari PP 179, PP 202, herb. 2183; BW. 1830 (Schram), 2783 (Schram), 3324 (Runtoboy 1), 3593 (Kalkman); Clemens 8215, 8263 A; NGF. 4560 (Hart); Warburg 20163.*

NEW BRITAIN. *NGF. 162 (Haas); Waterhouse 348, 409, 899.*

locality unknown:

Hort. Bot. Bog. VI E 2, VI E 13, VII B 9, VII B 10 (type *C. microcarpum f. minor* Hochr.), *VII B 10a.*

Ecology: Primary and secondary forests, mostly below 400 m, rarely up to 700(—1200) m. *Fl.* May—Nov., *fr.* May—Oct. (Dec. in New Britain).

Uses. The wood can be used as a light constructional timber. The wood of the buttresses is said to be one of the components of the scented wood *kaju rasamala.* The oily parts of the resin are used as a balm on wounds and for hair lotions; in New Guinea it is for the latter purpose mixed with coconut-oil.

Notes. Closely related to *C. balsamiferum* and on the whole rather uniform. The two forms, mentioned by H. J. Lam (1932b, *l. c.*), a small-leaved and a large-leaved one, are only vaguely distinguishable.

Some specimens from New Guinea have fairly coriaceous leaflets; they have been collected at *c.* 1000 m. Some specimens, especially one from Morotai (*Main & Aden 1425*), are long remaining densely tomentose.

Guillaumin (1911c, 710) was the first to record this species from Indo-China. In this he based himself on *Pimela oleosa* Lour., typified by Indo-Chinese material and with a reference to the E. Malaysian *Nanarium oleosum* of Rumphius (the type of *Amyris oleosa* Lamk). Poiret *l. c.* erroneously referred Loureiro's species to *C. microcarpum* Willd. See also Merrill (1935, 227). Already Engler (1883, *l. c.*) expressed doubt about this synonymy and H. J. Lam (1932a, 208) gave a new name to the species of Loureiro, *viz. C. engleri* H. J. Lam, which is up till now only known from Loureiro's description.

35. **Canarium balsamiferum** Willdenow, 1806, 760; Engler, 1883, 150; Merrill, 1917, 301; Heyne, 1927, 876; Lam, 1932a, t. 16 f. 127 c 2; 1932b, 485, t. 12 f. 75; Cretzoiu, 1934, 266, *incl. var. typicum* and *var. englerianum;* Leenhouts, 1956, 279. — *C. odoriferum leve* Rumphius, 1741, 156, t. 50. — *Boswellia balsamifera* Sprengel, 1825, 313. — *Pimela glabra* Blume, 1850, 222, *excl. basionym Boswellia glabra* Roxb. — *Pimela paucijuga* Blume, 1850, 226. — *Canariopsis glabra* Blume *ex* Miquel, 1859, 653. — *Canariopsis paucijuga* Blume *ex* Miquel, *l. c.*; Engler, 1883, 151; Merrill, 1917, 305. — *C. celebicum* Engler *ex* Koorders, 1903b, 97, *nom. nud.;* Koorders, 1922a, t. 31; 1922b, 17. — *C. englerianum* Hochreutiner, 1904, 56; 1910, 845. — *C. longissimum* Hochreutiner, 1904, 58; 1910, 846. — *C. rooseboomii* Hochreutiner, 1904, 62; 1910, 848. — *C. poeloetimbeo* Engler *ex* Hochreutiner, 1904, 58, *nom. nud.*; Koorders-Schumacher, 1914, 61.

Type: Celebes, Malili, Usu, alt. 200 m, Jan. 31, 1934, *FRI. Cel./II-234,* fr., neotype (L; isotype in BO).

Buttressed tree, 15—30 m by 20—40(—70) cm. *Branchlets* ½—1¾ cm thick, glabrescent; pith with many vascular strands, which are sometimes arranged in two concentric cylinders. *Stipules* none. *Leaves* (3—)5—8-jugate, glabrous. *Leaflets* lanceolate to oblong, 9—24 by 2—9¼ cm, herbaceous to coriaceous; base of the laterals often strongly oblique, broadly cuneate to slightly cordate; margin entire; apex acute, rather abruptly, short (*c.* 1 cm) and slenderly blunt-acuminate; nerves 8—15 pairs (angle 60—70°), little curved, rarely distinctly interarching close to the margin; reticulations very slender and rather dense. *Inflorescences* axillary, glabrescent, slender, ♂ ones narrowly thyrsoid, 10—50 cm, main branches *c.* 2(—10) cm, patent, thyrsoid, 3—11-flowered; ♀ ones mostly racemose, 4—10 cm. *Flowers* (nearly) glabrous, ♂ ones 1 cm long, ♀ ones 5—6 mm. *Calyx* 3—5 mm high. *Stamens* glabrous, in ♂ flowers connate for 1—2 mm, in ♀ ones very slightly connate. *Disk* in ♂ flowers thick and ovoid to club-shaped, 4 mm high, more or less deeply (3—)6-lobed, with a central canal, pubescent, inner side and apex with long, erect hairs; in ♀ flowers cupular, ¾ mm high, 6-undulate, pubescent outside and long-fimbriate. *Pistil* densely pubescent except at the base; in ♂ flowers none. *Infructescences* in the more coarse specimens short and dense, 5—8 cm long, with 2—5 rather large, fertile fruits; in more slender specimens up to 25 cm long, slender, fruits smaller and often some of them sterile; calyx *c.* 7 mm diam., flat, 3-lobed, lobes reflexed. *Fruits* ovoid, acute, specially at the apex, round or slightly trigonous in cross-section, 2—2½—4 by 1¼—2 cm, glabrous or slightly pubescent at the top; lids conspicuous, faintly keeled, c. 2½ mm thick. *Seeds* 3.

Distribution: Celebes, Moluccas (Talaud Islands, Morotai, Halmaheira, Buru, Ambon, Kai Islands), New Guinea (*incl.* also Louisiada Isl.).

CELEBES. *FRI. bb. 7532, bb. 17292 (Tumbel 6), bb. 17566, bb. 28218, bb. 28235, Cel./II-129, Cel./II-234* (neotype), *Cel./II-478; Hochreutiner Pl. Bogor. exsicc. 121* (type *C. longissimum* Hochr.); *Koorders 16296β; Riedel 5709; Teysmann 11974, 12384, 12424.*

MOLUCCAS. Talaud Islands: *Lam 2870, 2978.* — Morotai: *FRI. bb. 33770 (Tangkilisan 74), bb. 33844 (Tangkilisan 156), bb. 33905 (Tangkilisan 235).* — Halmaheira: *FRI. bb. 24936.* — Buru: *Hort. Bot. Bog. VI D 11 (Binnendijk 4742)* (type *C. englerianum* Hochr.). — Ambon: *Korthals s.n.* — Kai Islands: *Hort. Bot. Bog. VI D 12 (Jaheri 2392)* (type *C. rooseboomii* Hochr.); *Jaheri 477.*

NEW GUINEA. *Brass 21962.* — Louisiada Isl.: *Brass 27713.*

locality unknown:
Hort. Bot. Bog. VI D 14.

Ecology: In primary forests from low altitudes up to *c.* 700 m. *Fl. fr.* (mainly) May—July.

Uses. According to Rumphius the aromatic oil from the resin is highly estimated, as it is sweeter scented than that of most other *Canarium* species known to him.

Notes. The best subdivision of this variable species is that given by H. J .Lam (1932b, *l. c.*). As the characters are very vague and as the 3 forms are not geographically separated, he did not provide them with names.

The species is closely related to *C. trigonum* and, though in a lesser degree, to *C. oleosum.*

36. **Canarium trigonum** H. J. Lam, 1932a, 219; 1932b, 487, t. 14 f. 95; Leenhouts, 1956, 280.

Type: Celebes, Malili Distr., near Kawatta, alt. 200 m, *FRI. Cel./II-401* (*Gonggrijp 2*), ♀ & fr., lectotype (BO; isotypes in K, L).

Tree, 20—28 m by 20—30 cm. *Branchlets* 3—4 mm thick, glabrescent; pith with a peripheral cylinder of some large to many small vascular strands, in the latter case appressed to the wood. *Stipules* absent. *Leaves* 2—5-jugate, glabrous. *Leaflets* elliptic-lanceolate, 5½—15 by 2½—5 cm, chartaceous; base cuneate; margin entire; apex acute, rather abruptly, long and slender (5—15 by 1½—2 mm) blunt-acuminate; nerves 7—12 pairs (angle 55—65°), curved, not arching except in the apical part; reticulations lax. *Inflorescences* axillary, glabrous, slender, ♂ ones narrowly thyrsoid, *c.* 20 cm long, main branches patent, up to 1½ cm, 2—3-flowered; ♀ ones racemose, 4—8 cm long, with few flowers only. *Flowers* nearly glabrous, ♂ ones 4—5, ♀ 7—8 mm long. *Calyx c.* 3 mm long. *Stamens* in ♂ flowers connate for 1 mm, filaments pilose, anthers acute-acuminate; in ♀ flowers free, totally pilose. *Disk* cylindrical in ♂ flowers, 2 mm high, densely pubescent, with or without a central canal; in ♀ flowers cupular, 6-lobed, 1 mm high, fimbriate. *Pistil* densely pilose, in ♂ flowers absent. *Infructescences* small, with only one fruit; calyx flat with reflexed lobes, 7 mm diam. *Fruits* shortly ovoid, trigonous in cross-section, *c.* 3½ by 2½ cm; pyrene rounded-triangular in cross-section, the sides flat to slightly concave; lids thick; cells equally well developed.

Distribution: Central Celebes.

CELEBES. *FRI. Cel./II-401 (Gonggrijp 2)* (lectotype), *Cel./II-416 (Gonggrijp 17)* (syntype).

Ecology: In old forests, 200 m. *Fl. fr.* May—July.

Note. This apparently rare species is closely related both to *C. balsamiferum* and to *C. euryphyllum*. It is best characterized by its fruits.

37. **Canarium euryphyllum** Perkins, 1904, 99; Merrill, 1923, 350; Lam, 1932a, t. 12 f. 80; 1932b, 531; Leenhouts, 1956, 280. — *C. perkinsae* Merrill, 1906a, 26; 1923, 352. — *C. todayense* Elmer, 1911, 1087. — *C. purpureum* Elmer, 1912, 1503. — *C. ramosii* Merrill, 1913, 374, *incl.* also *var. parvum*; 1923, 353; Lam, 1932b, 532. — *C. paucinervium* Merrill, 1914b, 364; 1923, 352. — *C. stenophyllum* Merrill, 1915a, 25; 1923, 354. — *C. microphyllum* Merrill, 1918b, 304; 1923, 351.

Type: Philippines, Luzon, Principe Prov., Baler, 1903, *Merrill 1045*, fr. (PNH †; isotypes in K, NY).

Tree 10—15(—40) m by 10—25(—40) cm. *Branchlets* ¼—½ cm thick, often glabrescent; pith with a peripheral cylinder of small vascular strands, the few central ones rarely arranged into a second cylinder. *Stipules* none. *Leaves* 2—7-jugate. *Leaflets* elliptic (to lanceolate), slightly falcate, 4½—18 by 2—6 cm, very rarely nearly orbicular and straight, 3½ cm diam., mostly chartaceous; base cuneate (to rounded); margin entire; apex abruptly, long and slender, blunt-acuminate; nerves (5—)8—10(—15) pairs (angle variable), straight, gradually curved towards the margin and indistinctly arching at *c.* 2 mm from it. *Inflorescences* axillary, thyrsoid to racemose, 15—20 cm, glabrescent. *Flowers c.* 1—1½ cm long, glabrous to very shortly pilose outside, specially the corolla. *Calyx* 3 mm high, widely cupular. *Corolla* much exserted, not slender. *Stamens* glabrous, in ♂ flowers faintly connate. *Disk* in ♂ flowers tubular to cupular, up to 2½ mm high, fimbriate, on the inner side densely pilose; in ♀ flowers annular, 6-undulate, 1 mm high, long-pilose. *Pistil* pilose, in ♂ flowers nearly always totally absent. *Infructescences* 10—20 cm long, glabrous, with up to 5 fruits; calyx flat, triangular, 5 mm diam., lobes reflexed. *Fruits* broadly elliptic, broadly triangular in cross-section, 2¾—3 by 1¼—1¾ cm, glabrescent except for the apex; pyrene smooth; lids 2 mm thick; fruits often sterile. *Seed* 1; sterile cells rather strongly reduced.

Distribution: Philippines (Palawan excepted).

Taxonomy: The following two varieties are distinguishable:

a. var. **euryphyllum.** — *C. perkinsae* Merr. — *C. todayense* Elm. — *C. purpureum* Elm. — *C. stenophyllum* Merr. — *C. microphyllum* Merr.

Branchlets soon glabrescent. Leaves (2—)4—7-jugate, (nearly) glabrous. Leaflets falcate, 4½—10—12 by 2—4 cm, rarely straight and orbicular, rather stiff. Inflorescences narrowly thyrsoid to racemose; partial panicles often sessile, 2—3(—5)-flowered, rarely stalked, up to 3½ cm long, and with up to 12 flowers. Flowers *c.* 1 cm long. Fruits up to 1½ cm broad, red when fresh; often sterile.

Distribution: as the species.

PHILIPPINES. Mindoro: *Bartlett 13545; BS. 39553, 39622, 40841, 40904; Edaño 3238; FB. 3622 (Merritt), 3695 (Merritt); Mac.Gregor 121* (syntype *C. perkinsae* Merr.); *PNH. 13783 (Sulit 4067), 17426 (Conklin 71), 17653 (Sulit & Conklin 5073), 17707 (Sulit & Conklin), 18694 (Conklin 279).* — Batanes Isl.: *BS. 80420 (Ramos 501), 80421 (Ramos 990), 80427 (Ramos 506).* — Babuyan Isl.: *BS. 79295 (Edaño).* — Luzon: *BS. 20539; Elmer 14644; FB. 30315 (Sulit 132); Loher 14083; Merrill 1045* (type), *1081* (paratype); *PNH. 9769 (Canicosa); Ramos 1477, 1550* (type *C. stenophyllum* Merr.); *Vidal 158.* — Catanduanes: *BS. 30351* (type *C. microphyllum* Merr.). — Sibuyan: *Elmer 12145* (syntype *C. purpureum* Elm.), *12219* (syntype *C. purpureum* Elm.); *FB. 18862 (Fischer), 27039 (Sajor).* — Samar: *BS. 17453.* — Negros: *Elmer 9627, 10053.* — Panay: *BS. 31147 (Ramos & Edaño), 32288 (MacGregor), 32371 (MacGregor), 35277 (Martelino & Edaño), 35333 (Martelino & Edaño), 42486 (Edaño), 45992 (Edaño), 46045 (Edaño); FB. 17836 (Cortes & Rendal), 24597 (Achacoso); PNH. 33882 (Taleon 1472).* — Mindanao: *Clemens 494, 684; Elmer 10845, 11268* (type *C. todayense* Elm.); *PNH. 9939 (Sulit 3232).* — Bucas Grande Isl.: *BS. 35043 (Ramos & Pascasio), 35138 (Ramos & Pascasio).*

Ecology: Rather common tree in forests, up to 500 m (on Mt Katanglad, Mindanao, once collected at 1700 m). *Fl.* Nov.—June, *fr.* (mainly) April—Aug.

Uses. The wood is often said to be very hard.

b. var. **ramosii** (Merr.) Leenhouts, 1956, 280. — *C. ramosii* Merr. — *C. paucinervium* Merr.

Type: Philippines, Leyte, Dagami, Aug. 1912, *Ramos 1168,* ♂ (PNH †; isotypes in BRSL, FI, G, U, Z).

The main differences to var. *euryphyllum* are: Rather densely, hirsutely pilose on the branchlets, petioles, leaf-rhachids, petiolules and leaflets (midrib above, all nerves beneath). Leaves mainly 2—4-jugate. Leaflets less falcate, mainly 12—18 by 4½—6 cm, less stiff. Inflorescences more often thyrsoid and more-flowered. Flowers longer (14 mm). Fruits slightly broader (1½—1¾ cm), black; no sterile ones seen.

Distribution: Philippines (Samar, Leyte, Mindanao: Surigao Prov. only).

PHILIPPINES. Samar: *BS. 24496 (Ramos); FB. 24598 (Sasquety).* — Leyte: *Ramos 1168* (type); *Wenzel 103* (type *C. ramosii* Merr. *var. parvum* Merr.), *468, 875, 1517.* — Mindanao: *BS. 83472 (Ramos & Convocar); Wenzel 2986, 3144, 3188.*

Ecology: In forests at low altitudes. *Fl.* June—Sept., *fr.* (mainly) April—Aug.

Note. This species, apparently related to *C. balsamiferum*, is well characterized by its fruits, and by its flowers with a long, much exserted, though not very slender corolla. The leaves are more distinctly caudate than those of the related species.

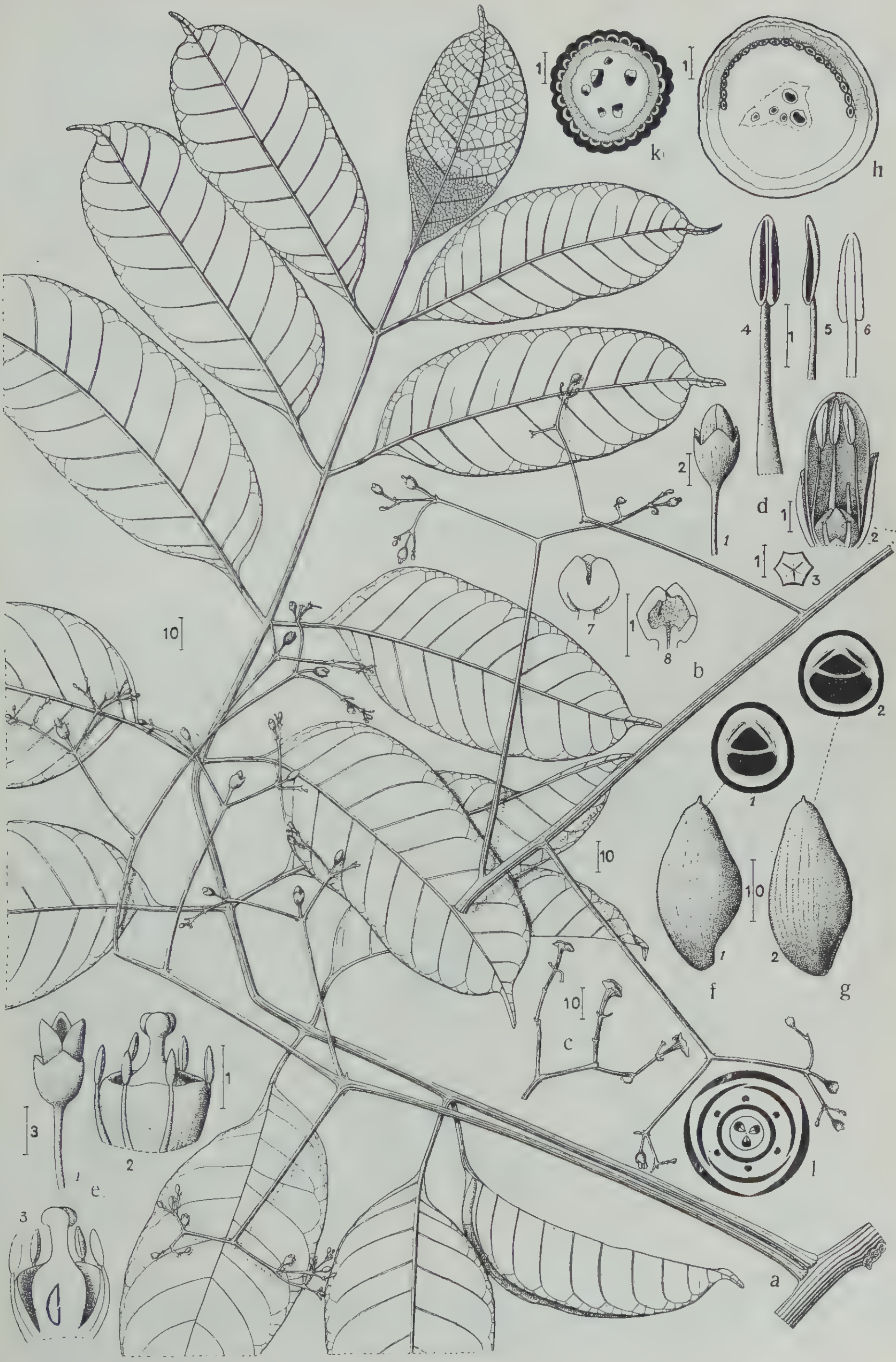
38. **Canarium gracile** Engler, 1883, 140; Elmer, 1911, 1078; Merrill, 1923, 350; Lam, 1932a, t. 12 f. 84; 1932b, 531; Leenhouts, 1956, 282, f. 20c & 21 m. — *C. antonii* Elmer (*ex* Merrill, 1923, 350, *in syn.*), 1939, 3711, *descr. angl.* — *Fig. 22.*

Type: Philippines, Luzon, Tayabas Prov., 1841, *Cuming 795,* ♂ (L; isotypes in BM, FI, K, MEL, W).

Often shrub-like tree, 5—15 m by 5—25 cm. *Branchlets* slender, glabrescent; pith loose with indistinct vascular strands, most of them peripherally arranged. *Stipules* absent. *Leaves* (1—)4—5(—7)-jugate, glabrous. *Leaflets* oblique-elliptic, slightly falcate, (5—)8—14 by (2—)3—4½ cm, chartaceous; base cuneate; margin entire; apex abruptly, rather long and broadly (up to 2 by ½ cm) blunt-acuminate, acumen curved; nerves 9—11 pairs (angle *c.* 75° at the broader, 50—60° at the narrower side), straight to faintly curved, gradually more so towards the margin, more or less distinctly arching in the apical part only; reticulations lax. *Inflorescences* axillary, broadly and laxly thyrsoid, ♂ ones mostly 30—40 cm, ♀ ones 60—80 cm long, glabrous; all axes very slender; main branches patent, up to 10 cm (♀ ones up to 15 cm), repeatedly laxly cymose, terminal parts monochasial, 2—3 cm long, *c.* 10-flowered (♀ ones with fewer flowers); *bracts* broadly deltoid. *Flowers* 6—7 mm long, slender, glabrous outside, ♀ ones sometimes with a slightly concave receptacle. *Calyx* 3—3½ mm high. *Stamens* glabrous, slightly confluent at the base. *Disk* in ♂ flowers strongly developed, 2½ mm high, glabrous, *c.* globose, 6-lobed, ½ mm stalked, with a narrow central, conical canal, which is sometimes closed at the top, and which sometimes includes a minute rudiment of the pistil; in ♀ flowers 1 mm high, annular, faintly 6-lobed. *Pistil* glabrous. *Infructescences* with few fruits; calyx saucer-shaped, 3-lobed, 1 cm diam. *Fruits* ovate-oblong to bottle-shaped, bulging on one side, blunt at base and apex, the latter pointed by the persistent style-base, round in cross-section, 2½—3½ by 1¼—1½ cm, smooth, glabrous; pericarp very thin; pyrene smooth; lids 1—1½ mm thick, bony. *Seed* 1; sterile cells much reduced, linear, *c.* 6 by 1 mm; central canal strongly developed, 4—5 mm diam.

Distribution: Philippines (Palawan excepted).

Fig. 22. *C. gracile* — a. leaf and ♂ inflorescence; b. ♀ inflorescence; c. part of infructescence; d. ♂ flower: 1. bud, 2. ditto opened, 3. disk from above, 4—6. stamens, 7. disk, 8. ditto in longitudinal section; e. ♀ flower: 1. habit, 2. calyx and corolla removed, 3. ditto in longitudinal section; f—g. fruits with their cross-sections; h. cross-section of twig (only one half of the anatomy drawn); k. cross-section of petiole; l. diagram of ♀ flower. (a, d, h, k. from *BS. 28555;* b—c, e—f, l. from *Elmer 7322;* g. from *Elmer 13337*) (dimensions in mm). *del.* Amir Namsah and Darmosoediro.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PHILIPPINES. Mindoro: *BS. 41080 (Ramos); FB. 3750 (Merritt), 4094 (Merritt); Whitford 1406, 1431.* — Luzon: *Adduru 133; BS. 13313 (Ramos), 20891 (Escritor), 23474 (Ramos), 28555 (Ramos & Edaño), 45199 (Ramos & Edaño), 45382 (Ramos & Edaño), 46665 (Ramos & Edaño); Cuming 795* (type), *800, 849, 885; Elmer 15823, 16133; FB. 25320 (Manuel); PNH. 37202 (Edaño); Ramos 1130; Vidal 162, 2287.* — Polillo: *BS. 10367 (MacGregor).* — Samar: *BS. 17461 (Ramos), 24511 (Ramos); PNH. 6235 (Sulit 2818).* — Leyte: *Elmer 7322; Wenzel 373.* — Biliran: *BS. 18716 (MacGregor).* — Mindanao: *BS. 83474 (Ramos & Convocar 2), 84125 (Ramos & Convocar 564); Elmer 10944, 11076, 13337; PNH. 10641 (Mendoza & Convocar 553), 11028 (Edaño 1600), 11268 (Edaño 1972); Williams 3040.*

Ecology: In primary forests at low and medium altitudes, rarely up to 600 m. *Fl.* Jan.—Oct., *fr.* (Jan.—)May—July.

Uses. Wood moderately hard.

Note. Apparently related to *C. euryphyllum.* Best characterized by its very widely branched leaves, inflorescences, and infructescences, and by its peculiar ventricose fruits, which, moreover, show an exceptionally large central cavity in cross-section.

39. **Canarium kostermansii** Leenhouts, 1955b, 191, f. 5a; 1956, 281. — *Fig. 23.*

Type: E. Borneo, E. Kutei, Sangkulirang Subdiv., G. Tepian Lobang on Menubar River, June 18, 1951, *Kostermans 5315,* ♀ (L; isotypes in BM, K).

Tree, 30 m by 60 cm. *Branchlets* rather slender, up to 1 cm thick, brown tomentose, ± glabrescent; pith with 2 concentric cylinders of vascular strands. *Stipules* very caducous, inserted on the petiole 1/3—3 cm from its base, subulate, *c.* 6 mm, leaving a prominent scar. *Leaves* 4—7-jugate. *Leaflets* lanceolate, slightly oblique, 10—22 by 3—7 cm, rather stiff chartaceous, glabrous; base unequally, broadly cuneate; margin entire; apex gradually narrowed into a long and slender (up to 15 by 3—4 mm), acute acumen; nerves 22—25 pairs (angle *c.* 60°), straight, faintly curving towards the margin, abruptly arching very close to the margin. *Inflorescences* (♂ unknown) axillary, racemose, 10—15 cm long, thinly tomentose, glabrescent. *Flowers* (♂ unknown) 12 mm long, with a slightly concave receptacle. *Calyx* 9 mm high. *Stamens* 4¼ and 5½ mm long, connate for 1½ mm; filaments glabrous. *Disk* annular, ½ mm high, up to 1½ mm fimbriate. *Pistil* glabrous. *Infructescences* racemose, 10—20 cm long, with 3—6 fruits; calyx funnel-shaped, 3-lobed, c. 1 cm diam. *Fruits* spindle-shaped, 3 by 1¼ cm, glabrous; pyrene faintly 5-angular in cross-section, smooth; lids *c.* 2 mm thick. *Seed* 1; sterile cells moderately reduced.

Distribution: Borneo.

BORNEO. *Kostermans 5315* (type); *NBFD. SAN 17153 (Wood).*

Ecology: Alt. up to *c.* 600 m. *Fl.* June, *fr.* Oct.

Note. This species is apparently allied with *C. pilosum.* It is mainly different from the latter by its more-jugate leaves, the large number of nerves, and by its fruits.

40. **Canarium pilosum** Bennett, 1875a, 533; 1875b, 103; Engler, 1883, 121; King, 1894b, 243; Ridley, 1900a, 58; 1922, 372, f. 39, *incl.* also *var. hirtellum;* Lam, 1932a, 212, t. 13 f. 104i, *incl.* also *var. hirtellum;* 1932b,

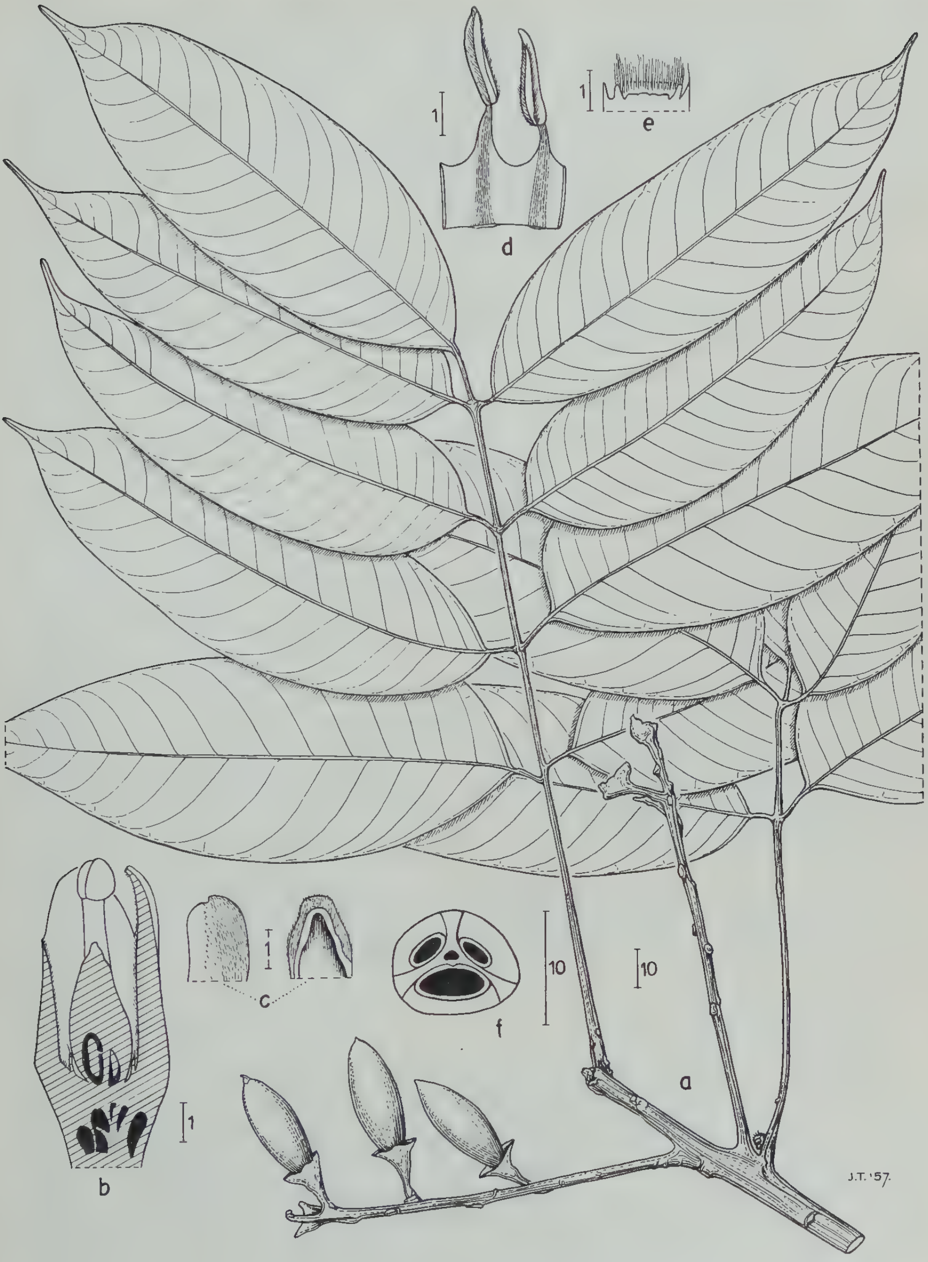


Fig. 23. *C. kostermansii* — a. twig with infructescences; b. longitudinal section of old ♀ flower; c. apex of petal; d. staminal tube of ♀ flower from inside; e. disk of ♀ flower in section; f. cross-section of fruit-kernel. (a. and f. from *NBFD SAN 17153;* b—e. from *Kostermans 5315*) (dimensions in mm).

472, t. 11 f. 68; Burkill, 1935, 432; Leenhouts, 1955a, 24, f. 11; 1956, 281, f. 21n. — *C. grandiflorum* Bennett, 1875a, 533; 1875b, 103; Engler, 1883, 122; King, 1894b, 242; Ridley, 1900a, 58; 1922, 370; Burkill, 1935, 429. — *C. hirtellum* Bennett, 1875a, 534; 1875b, 103; Hooker, 1887, t. 1575; Engler, 1883, 121; King, 1894b, 244. — *C. motleyanum* Engler, 1883, 133; Merrill, 1921, 317. — *Dacryodes scandens* Husson, 1952, 164, f. 1; Kalkman, 1954, 518.

Type: Malay Peninsula, Nov. 16, 1867, *Maingay 3103* (= *Kew distr. 302)*, ♂ (K; isotype in CAL).

Tree 10—28(—37) m by 20—45(—65) cm; buttresses, if present, up to 1 m high. *Branchlets* slender, ½—1 cm thick, long remaining densely woolly pubescent; pith with a peripheral cylinder of vascular strands, rarely also some in the central part. *Stipules* mostly persistent, inserted at the base of the petiole or on the petiole up to 2¼ cm from the base, subulate, up to 2 cm, sometimes absent. *Leaves* (0—)2—4(—6)-jugate, more or less pubescent in all parts, rarely entirely glabrous. *Leaflets* ovate to oblong-lanceolate, 4—25 by 1½—10 cm, chartaceous, totally glabrous to pubescent on the midrib above and woolly pubescent beneath; base (subcordate or) rounded to broadly cuneate; margin minutely serrulate to entire; apex gradually to subabruptly, short and bluntly to long and acutely acuminate; nerves 8—15 pairs (angle from base to apex 80—50°), curving, geniculate near the margin, often more or less arching. *Inflorescences* axillary to pseudoterminal, rarely terminal, glabrescent, rather few-flowered, ♂ ones narrowly thyrsoid, 4—10—26 cm long, ♀ ones more racemose, 1½—10 cm. *Flowers* ½—1¼ cm long, slender, specially the ♂ ones. *Calyx* in ♂ flowers 2—4 mm high, in ♀ ones 5—6 mm. *Stamens* glabrous, in ♂ flowers 6—8 mm long, connate for ½—3 mm; in ♀ flowers 4 mm long, nearly entirely connate. *Disk* cupular, up to 1 mm high, pilose. *Pistil* in ♂ flowers very small or absent. *Infructescences* 1½—10 cm long, with 1—4(—8) fruits crowded at the top of the stalk; calyx saucer-shaped, 3-lobed, 6—13 mm diam. *Fruits* see under ssp.

Distribution: Sumatra (*incl.* also Simalur), Malay Peninsula, Borneo.

Taxonomy. The following two subspecies — in S. Sumatra and E. Borneo linked together by some intermediate specimens — are distinguishable:

A. Subsp. **pilosum**. — *C. grandiflorum* Benn. — *C. hirtellum* Benn. — *C. motleyanum* Engl.

Stipules nearly always present. Flowers 1 cm long or more, densely pubescent outside. Stamens in ♂ flowers connate for 2—3 mm. Pistil pilose. Fruits oblong (to ovoid), at the apex nearly always truncate and with 3 'shoulders', rarely tapering, mostly rounded 3-angular in cross-section, (1¾—)2¼—3¼ by (¾—)1—1½ cm, glabrous except sometimes at apex; pyrene smooth, the sides concave to faintly keeled; lids 1½(—3) mm thick. Seed nearly always 1, the sterile cells strongly reduced.

Distribution: as the species.

SUMATRA. *Bartlett 7345; Dumas 1632; FRI. bb. 9130, bb. 32099, 43 T 1P 702, 180 T 1P 702; herb. L 897.363—301; Junghuhn 16.* — Simalur: *Achmad 483, 640, 662, 845, 980, 1160, 1472, 1561.*

MALAY PENINSULA. *Beccari herb. 2196; Burkill 862, 1284; Curtis 630, 650, 656,* *2251; Hullett 516; KEP. 361 (Rahman), 829, 918 (Hamid), 9633 (Omar), 18188 (Symington), 32822 (Walton), 41015 (Sow), 54666, 54810, 54828, 65600, 69013, 73054, 73513; King's coll. 2983, 6054, 6138, 6519, 6778, 7901, 8819; Mahamet 1869; Maingay 1388 (= Kew distr. 312)* (type *C. grandiflorum* Benn.), *1969 (= Kew distr. 302), 3103 (= Kew distr. 302)* (type); *Ridley 289, 656, 1869 (= Mahomet 1869?), 3976, 4654, 12570; Scortechini 424b; SF. 13129 (Haniff), 20088 (Holttum), 21429 (Henderson), 26135 (Corner), 26197 (Corner), 31590 (Corner), 33142 (Corner), 34995 (Ngadiman), 36135 (Corner), 36420 (Ngadiman), 37130 (Corner), 39996 (Sinclair); Wallich 8100, 8102* (syntype *C. hirtellum* Benn.), *9047* (syntype *C. hirtellum* Benn.); *Wray Jr. 2645.*

Borneo. *Barber 283* (syntype *C. motleyanum* Engl.); *Motley 243* (type *C. motleyanum* Engl.); *NBFD. SAN 16326 (Wood), SAN 16530 (Wood).*

cultivated:

Fiji Islands. *Gillespie 3434.*

Ecology: Rather common in primary forests, also in swamps, up to *c.* 350(—1250) m. *Fl.* (Dec.—)March—Aug.(—Oct.), *fruiting* (March—) April—July(—Nov.).

Uses. The wood is said to be durable against insects and is used for house-building.

Note. In one specimen (*Henderson SF. 21429*) I found fertile fruits and ♂ flowers.

B. Subsp. **borneensis** Leenhouts, 1955b, 193, f. 5d; 1956, 282. — *Dacryodes scandens* Husson.

Type: North Borneo, Mt Kinabalu, Penataran basin, near Bidow-Bidow Falls, alt. 1500 m, Sept. 1, 1933, *Clemens 40163*, ♀ & fr. (L; isotypes in A, BM, BO, G, NY).

Tree *c.* 10(—25) m high, very rarely a pseudoliane. Stipules absent. Leaves 0—5-jugate. Leaflets always glabrous; base sometimes subcordate; margin always entire; intermediate veins more strongly developed. Inflorescences narrower and with few flowers. Flowers glabrous, ♂ ones *c.* 5 mm long, less slender. Stamens in ♂ flowers slightly confluent at base. Disk in ♂ flowers rather variable, with or without a rudimentary pistil. Pistil in ♀ flowers glabrous. Fruits ellipsoid to fusiform, tapering at base and apex, 3¾—4½ by 1½ cm.

Distribution: Borneo (Mt Kinabalu).

Borneo. *Clemens 31095* (type *Dacryodes scandens* Husson), *40163* (type), *40546* (paratype), *40599* (paratype); *Kostermans 7140* (aff.), *7184* (aff.); *SF. 26356 (Carr)* (paratype).

Ecology: In forests, *c.* 1500 m. *Fl.* Sept.—Oct. (Jan., March), *fr.* April, July, Sept.—Oct.

Note. *C. pilosum* is apparently the centre of a group of rather closely related species, *viz. C. kostermansii, merrillii* — especially close to *C. pilosum* ssp. *borneensis* —, *album, pimela, parvum, subulatum, intermedium,* and *kipella*, moreover perhaps also *C. australianum*. *C. pilosum* itself is a rather variable species, especially its ssp. *borneensis*; ssp. *pilosum* is usually well characterized by the insertion of the stipules (on the petiole at a rather large distance from its base), by the long and very slender flowers, and by the fruits, which are often more or less truncate or even 'shouldered' at the apex. Most of the related species are much less variable; though in general appearance often very much resembling *C. pilosum*, they are constantly different each in a few characters.

41. Canarium merrillii H. J. Lam, 1929, 117; 1932a, 213, t. 16 f. 133, *incl. var. originarium & var. villosum*; 1932b, 489, t. 12 f. 76; Leenhouts, 1956, 282. — *non C. merrillii* Perkins, 1904, 98, *nom. nud.* (= *C. asperum* Benth.).

Type: North Borneo, Sandakan, Oct.—Dec. 1921, *Elmer 20326*, ♂ (PNH †; isotypes in A, BM, G, K, L, NY, P, SING, U, Z).

Small tree, 10—20 m by 15—40 cm. *Branchlets* slender, glabrescent; pith not very compact, with some large peripheral vascular strands. *Stipules* very caducous, inserted at the base of the petiole, or on the petiole up to 1 cm from the base, subulate, 2—5 mm. *Leaves* 0—5-jugate. *Leaflets* (ob)ovate to lanceolate, (3—)5½—16 by (1¼—)2¾—5½ cm, stiff chartaceous, upper side glabrous except the midrib, lower side with scattered to crowded papillae, sometimes each of them provided with a soft hair; base cuneate; margin entire; apex subabruptly narrowly acute-acuminate; nerves 6—14 pairs (angle 50—60°), gradually curving, more or less distinctly arching at some distance from the margin. *Inflorescences* glabrous or slightly pubescent, either in the upper leaf-axils, narrowly thyrsoid, few-flowered, or together forming one lax terminal panicle, in the latter case up to 30 cm long, main branches up to 15 cm, laxly thyrsoid, the ♂ ones with 15—20 flowers, ♀ ones with fewer flowers. *Flowers* 8—9 mm long, rather slender, nearly glabrous outside. *Calyx* 4—5 mm high. *Stamens* glabrous, in ♂ flowers 8 mm long, connate for ½—2¼ mm, in ♀ flowers 4—5 mm, connate for 2 mm. *Disk* 1½ mm high, fimbriate, in ♂ flowers cupular, rather thick, in ♀ flowers thinner and slightly 6-undulate. *Pistil* glabrous, in ♂ flowers absent. *Infructescences* shorter and more compressed than the inflorescences, main branches with 3—6 fruits each; calyx saucer-shaped, 3-lobed, 6—7 mm diam. *Fruits* elliptic, tapering specially to the apex, trigonous in cross-section, 2½—3 by 1.1—1½ cm, glabrous; pyrene rounded 3-angular, smooth; lids ½—1½ mm thick, bony. *Seeds* 1(—2), sterile cells compressed, linear.

Distribution: Borneo (specially Br. N. Borneo).

BORNEO. *Amdjah 1036* (paratype); *Beccari PB 239; Clemens 26808, 26808 A, 27158, 27159, 30712, 40585, 50212; Elmer 20326* (type); *Endert 4507* (type *C. merrillii var. villosum* H. J. Lam); *NBFD. 3249 (Orolfo), 9995 (Enchai), A 590 (Kadir), A 677 (Kadir), A 4379 (Wood & Wyatt-Smith); SF. 26715 (Carr).*

Ecology: In old forests, mostly at high altitudes (1000—1600 m), rarely in the lowlands. *Fl.* Sept.—March, *fr.* Jan.—Dec.

Uses. The wood is soft.

Notes. This species is related to *C. pilosum* (Sumatra, Malay Peninsula, Borneo), especially to its ssp. *borneensis*, and to *C. album* (Indo-China); mainly characterized by the scabrous lower side of the leaflets, a character which furthermore I only occasionally met with in *C. album*.

Though the inflorescences often look like being truly terminal, the terminal bud nearly always develops after anthesis and the infructescences are then segregated into a number of axillary ones.

42. Canarium album (Lour.) Raeuschel, 1797, 287; De Candolle, 1825, 80; Roemer et Schultes, 1829, 81; Hance, 1871, 38; Engler, 1883, 149; Guillaumin, 1908c, 617, t. 19 f. 1; 1909a, 238, f. 22^{12}, 240, f. 23^{1}; 1909c, 365; 1911c, 714, f. 76 (p.p. = *C. subulatum* Guill.); Hayata, 1911b, 52; Merrill, 1917, 304; Walker, 1928, 100, 102; Merrill, 1935, 226; Walker, 1954, 148, f. 82. — *non C. album* Blanco, 1837, 793 (= *C. luzonicum* A. Gray). — ? *C. sinense Cana* Rumphius, 1741, 154; Thunberg, 1784, 368. — *Pimela alba* Loureiro, 1790, 408; 1793, 495; Poiret, 1811, 72; Blume, 1850, 220. — *Hearnia balansae* De Candolle, 1894, 580. — *C. tonkinense* Engler, 1896, 240; Guillaumin, 1911c, 711 (p.p. = *C. parvum* Leenh.); 1946, 678 (*p. min. p.*, fig. excl.; the major part is *C. parvum* Leenh.). — *C. copaliferum* Chevalier, 1918, 807, *nom. nud.* — *Fig. 24.*

Type: Tonkin, Phù-Tho Prov., Chân-Mông For. Res., 21/22-4-1914, *Fleury in herb. Chevalier 30122,* ♀, neotype (L; isotype in P).

Tree, (4—)10—20(—30) m high, 14—50—150 cm diam. *Branchlets* 5—6 mm thick, the young parts fulvous tomentose, soon glabrescent, older parts sometimes gnarly by the strongly prominent scars of leaves and inflorescences; pith with a peripheral cylinder of small vascular strands, rarely moreover some strands in the central part. *Leaves* 3—6-jugate. *Stipules* present in the bud only, inserted on the twig next to the base of the petiole, even the scar usually nearly invisible. *Leaflets* usually distinctly sinuous (especially the basal pairs), lanceolate or elliptic (to ovate), 6½—14 by 2—5½ cm, chartaceous to coriaceous, gabrous or with some scattered bristles on the nerves below, lower side often minutely verrucose; base oblique, cuneate to rounded; margin entire; apex gradually to subabruptly acuminate, acumen up to 2 cm long, blunt; nerves 12—16 pairs (angle 65—75°), straight to faintly curved in the broader, strongly curved in the narrower side of the leaflet, more or less distinctly arching near the margin; intermediate veins sometimes distinctly developed; venation dense. *Inflorescences* axillary, minutely tomentose to glabrous, the ♂ ones thyrsoid, 15—30 cm long, many-flowered, the ♀ ones racemose, 3—6 cm long, with up to 12 flowers. *Flowers* sparsely tomentose to glabrous, ♂ ones 5½—8 mm long, ♀ ones *c.* 7 mm. *Calyx* 2½—3 mm, in ♀ flowers subtruncate. *Stamens* 6, glabrous, the filaments more than halfway (in ♀ flowers up to nearly totally) connate. *Disk* ♂ globular to cylindrical, 1—1½ mm high, faintly 6-lobed, with a central canal or solid, the upper side with some bristles; in ♀ flowers annular, faintly 3-undulated, 1 mm high, thick and fleshy, pilose on the inner surface. *Pistil* densely shortly pilose, in ♂ flowers minute or none. *Infructescences* 1½—15 cm long, with 1—6 fruits; the calyx flat, 3-lobed, ½ cm diam., the lobes recurved. *Fruits* ovoid to spindle-shaped, round in cross-section, 2½—3½ by 1½—2 cm, glabrous, white when mature; pericarp rather thick, coarsely wrinkled when dry; pyrene acuminate, rounded (to 6-angular) in cross-section, with a distinct groove between the blunt angle-ribs and the lids, the latter with a faint median rib, surface furthermore slightly undulated; lids 1½—2(—3) mm thick. *Seeds* 1—2, the sterile cells slightly reduced, round in cross-section.

Distribution: Annam (from about 16° N.L. northwards), Tonkin, Southern China (up to about 27° N.L.), and Hainan; as the species is much cultivated in the same region (especially in Southern China, also occasionally in Formosa, in Japan — Nagasaki — and in Okinawa Isl.) possibly part of the 'wild' specimens are naturalized ones.

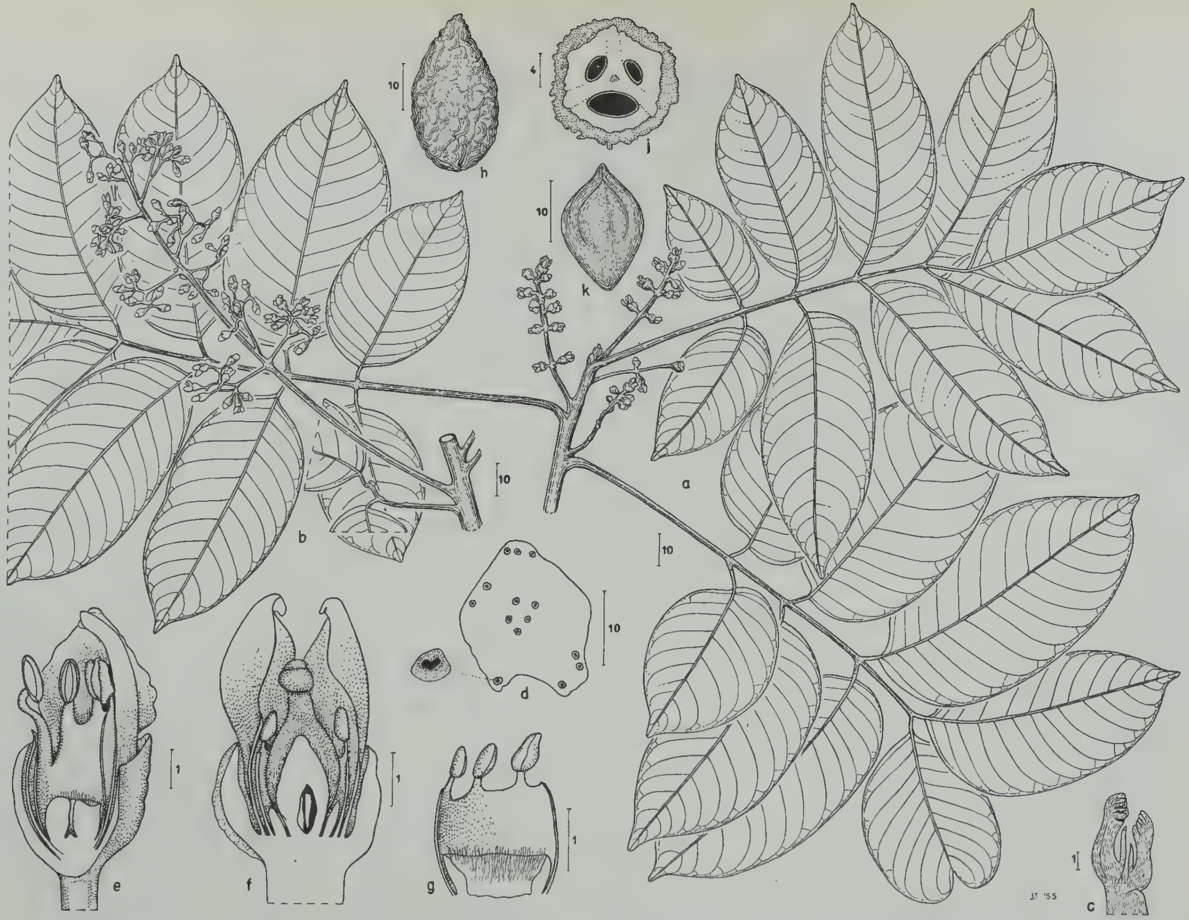


Fig. 24. *C. album* — a. twig with ♀ inflorescences; b. ♂ inflorescence; c. terminal bud, showing the stipules; d. twig, cross-section of the pith; e. longitudinal section of ♂ flower; f. ditto of ♀ flower; g. ditto, stamens and disk of ♀ flower; h. fruit; i. ditto, cross-section; k. fruit-kernel. (a, f—g. from *Wilson 3816;* b. from *Pételot 5751;* c. from *Fung 20421;* d. from *Lei 729;* e. from *Wilson 3375;* h. from *Canton Christian College 1890;* j—k. from *Lei 868*) (dimensions in mm).

Annam. *Fleury in herb. Chevalier 30141; Poilane 29914.*

Tonkin. *Balansa 3706* (type *Hearnia balansae* DC. & *C. tonkinense* Engl.); *Casalta 5; Fleury in herb. Chevalier 30122* (neotype), *37542* (syntype *C. copaliferum* Chev.), *37921, 37960, 38026; Pételot 2592, 5751.*

China. Yunnan: *Wang 76379, 77759, 80718.* — Kwangsi: *Ching 7395, 8083.* — Kwang-tung: *Canton Christian College 1813 (Levine), 1890 (Levine); Tsiang 2101.* — Fukien: *Carles 572, 699; Chung 4662, 6860; Warburg 5579.*

Hainan. *Chun & Tso 43766; Fung 20421; How 70461, 70807; Lau 42, 1786, 1850, 3504, 26756; Lei 729, 868; Liang 62097, 63216, 63325, 63472; Tsang 432, 722; Wang 32908.*

cultivated:

Malay Peninsula. P. Penang: *SF. 3767 (Haniff).*

China. *Chung 2396, 2778, 7357, 8524; Dunn 90; Fang 2293; Feng 12394; Fortune 55, 55a; herb. Hance 15677; Keng 26; MacClure 1720, 1752, 1760; Wilson 3375, 3376, 3816.*

Japan. Nagasaki: *Thunberg Pl. obscurae 99.*

Okinawa Isl. acc. to Walker, 1954, *l. c.*

Ecology: In parklands to dense forests, on dry to moist soils, usually at medium alt. (400—1200 m). *Fl.* (March—)May—June(—Aug.), *fr.* June—Oct.(—Dec.).

Uses. Planted as an ornamental tree. The wood is not very durable; it is in use a. o. for cheap furniture and for matches. The resin also is in use, but most important are the fruits, which are a highly esteemed titbit, and from which the fleshy parts as well as the seeds are eaten, prepared in several ways. Furthermore, the nut is used for making carvings.

Notes. Morphology. In broad outline, there are some small differences between the specimens from China and those from Indo-China, especially in the ♂ inflorescences and flowers. The branches of the ♂ inflorescences in Chinese specimens are usually branched in the upper half only, and consequently the lateral cymes are distinctly stalked; in Indo-Chinese specimens, the cymes are branched almost from the base, moreover they are much shorter (the type-specimen of *C. tonkinense*, however, is very laxly thyrsoid). In addition, in ♂ flowers of Indo-Chinese specimens the ovarial rudiment is usually lacking, or, if present, very tiny, in Chinese specimens it is more often present and less strongly reduced. In my opinion, in both these characters the Chinese specimens are slightly more primitive than are the Indo-Chinese ones.

Stipules are always present in this species (in contradistinction to *C. pimela*), if only in the terminal bud, and it is often difficult detecting their scars in older leaves. This is why *C. tonkinense* was described by Engler, and afterwards by Guillaumin, as having no stipules at all.

Taxonomy. The present species belongs to the relationship of *C. pilosum*; apparently it is closest to *C. pimela* (same region; the latter is different by the absence of stipules, the more lax nervation, and the fruits, which are black when fresh, and almost smooth when dried). The most distinctive characters of the present species are the slightly sinuate leaflets, which are light greyish-green when dry and possess a very minute and dense venation.

Nomenclature. Rumphius's *C. sinense Cana* probably belongs to the present species rather than to *C. pimela* (his *Tsjacana* possibly is *C. pimela*, his *Tengio Cana* in my opinion is no *Canarium* at all).

43. Canarium pimela Leenhouts, *nov. nom.* — ? *C. sinense Tsjacana* Rumphius, 1741, 154. — *Pimela nigra* Loureiro, 1790, 407; 1793, 495; Blume, 1850, 220. — *C. pimela* König, 1805, 361, t. 7 f. 1, *nom. illeg.*; Persoon, 1807, 616; Sprengel, 1825, 125, *excl. syn. C. sylvestre*; De Candolle, 1825, 80; *non* Blume, 1826, 1162 (= *C. kipella*); Roemer & Schultes, 1829, 80, *excl. spec. Javanicae;* 1830, 1623; *non* Spanoghe, 1835, 346 (= *C. oleosum*); *non* Blanco, 1845, 545 (= *C. asperum)*; Hance, 1871, 38; Engler, 1883, 122; Forbes & Hemsley, 1886, 113; Merrill, 1917, 304; Walker, 1928, 103, 104; Merrill & Chun, 1935, 253; Merrill, 1935, 227. — *Lipara nigra* Loureiro *ex* Gomes, 1868, 30, *nom. nud.* — *C. nigrum* (Lour.) Engler, 1896, 240, *nom. illeg.*; Guillaumin, 1909a, 238 f. 22^{19}; 1909c, 365, 493; 1911c, 710; Chevalier, 1918, 806; Guillaumin, 1946, 677. — *non C. nigrum* Roxburgh, 1814, 49 (= *C. acutifolium). — Fig. 25.*

Type: Cochin-China, 1774, *Loureiro s. n.*, ♀ (P).

Tree, (7—)10—20(—30) m high, 15—150 cm diam. *Branchlets* 7—10 mm thick, glabrous; pith with a peripheral cylinder of vascular strands, moreover central part sometimes with some strands. *Leaves* 4—6-jugate, glabrous. No *stipules. Leaflets* oblique, often distinctly falcate, broad-elliptic (to ovate or suborbicular, rarely oblong), 6—17 by 2—7½ cm, chartaceous to coriaceous; base acute, often decurrent; margin entire; apex rather abruptly acuminate, acumen short, broad, and blunt; nerves (8—)11(—15) pairs (angle 70—75°), straight to faintly curved, more strongly curving and more or less distinctly arching near the margin; veins and veinlets coarsely reticulate. *Inflorescences* axillary, glabrous, laxly thyrsoid (♂) to subracemose (♀), 15—40 cm long, ♂ many-, ♀ few-flowered. *Flowers* (sub)glabrous, ♂ 7 mm, slender, ♀ 9 mm. *Calyx* in ♂ flowers 2½ mm, distinctly lobed, in ♀ flowers 3½—4 mm, subtruncate. *Corolla* in ♀ flowerbuds characteristically conical. *Stamens* 6, glabrous (except 2 rows of bristles on the anthers in ♀ flowers), in ♂ flowers nearly halfway, in ♀ flowers slightly more than halfway connate. *Disk* annular, ½—1 mm high, fimbriate, in ♂ flowers thick-fleshy, with a narrow central canal, in ♀ flowers thin, 6-undulate. *Pistil* glabrous, in ♂ flowers absent. *Infructescences* 8—35 cm long, lax, with 1—4 long-stalked fruits; calyx nearly flat, faintly triangular to suborbicular, 8—10 mm diam. *Fruits* narrowly-ovoid, 3—4 by 1¾—2 cm, circular to faintly triangular in cross-section, glabrous; pericarp thin, minutely wrinkled when dry; pyrene nearly circular in cross-section, smooth or with a faint median rib on the lids; lids c. 3 mm thick. *Seed(s)* 1—2; fertile cells usually with a distinct adaxial rib, sterile cells moderately reduced.

Distribution: Southern China (from about 27° N.L. southwards), Hainan, Tonkin, Laos, Annam, and Cambodja; as the species is much cultivated, especially in Southern China and Tonkin, possibly part of the 'wild' specimens are naturalized ones.

CHINA. Kwang-si: *Ching 6536; Morse 318.* — Kwang-tung: *Canton Christian College 775 (Levine), 2489 (To), 4000 (Laam); Ho 60121; MacClure 453 (CCC. 7101); Merrill 10929; Tsiang 469, 2168.* — without locality: *Chun 5287.*

HAINAN. *Chun & Tso 44379; Henry 8731; How 70764, 72094, 72644, 73381; Lau 26195, 26767; Liang 61765, 62447; MacClure 767; Wang 35669.*

TONKIN. *Balansa 3694, 4602; Bon 1545; Fleury in herb. Chevalier 30091, 37543, 37833, 37958; Pételot 2653; Service forestier de l'Indo-Chine 8, 57.*

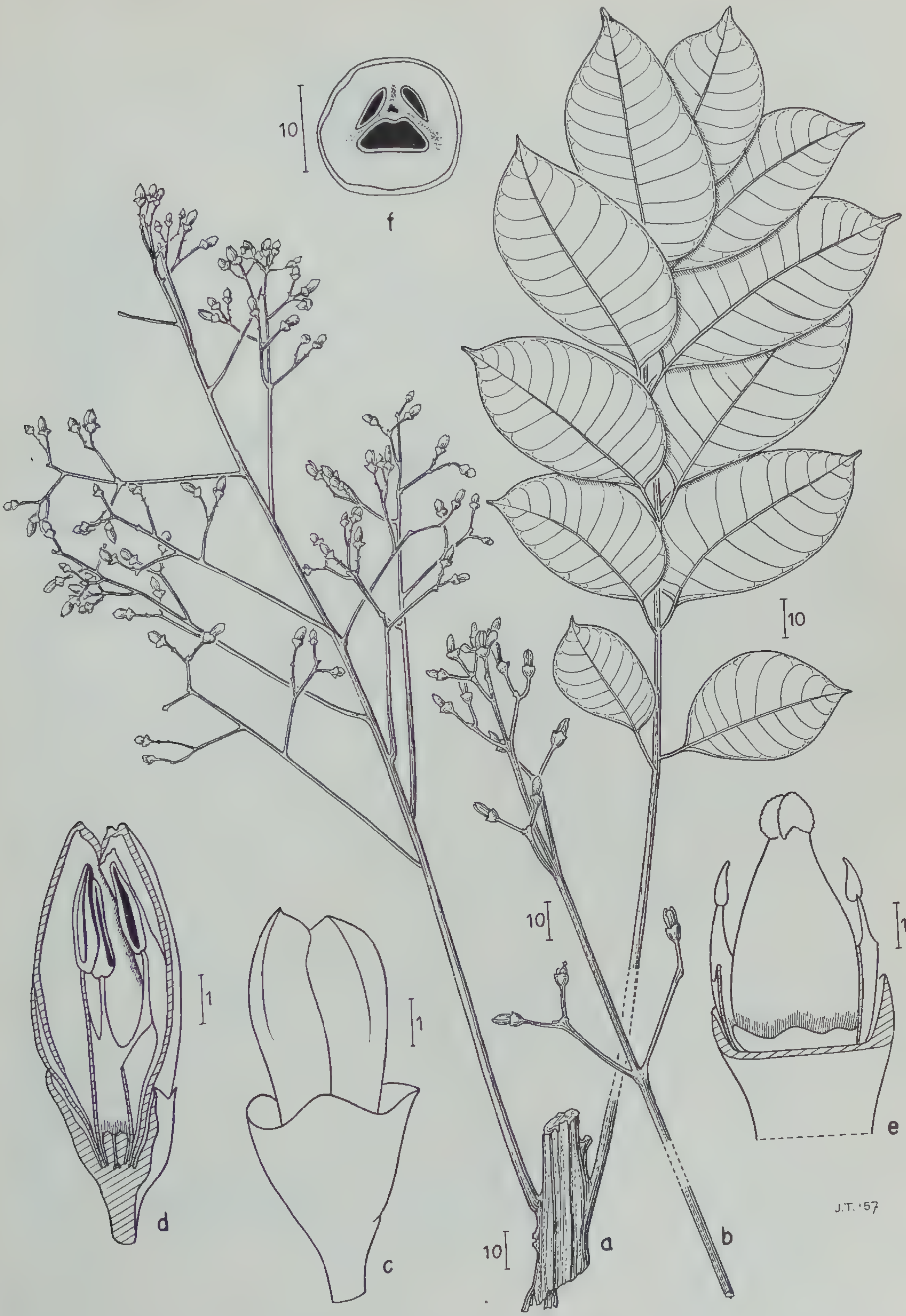


Fig. 25. *C. pimela* — a. twig with ♂ inflorescence; b. ♀ inflorescence; c. ♂ flower; d. ditto, longitudinal section; e. ♀ flower, partly cut, corolla removed; f. fruit in cross-section. (a. from *Balansa 4602;* b. from *Hance 5866;* c—d. from *How 72094;* e. from *Burke s.n.;* f. from *How 72644*) (dimensions in mm).

Laos. *Kerr 20890; Poilane 2013.*
Annam. *Loureiro s.n.* (type); *Poilane 10255.*
Cambodja. *Collard s.n.*
cultivated:
China. *Bodinier 1453; Hance 5866; Lingnan Univ. herb. 11112 (To); MacClure 1721 (CCC. 13545), 1756 (CCC. 13580), 1757 (CCC. 13581); Wright 110*
Indo-China. *Balansa 3856; Fleury in herb. Chevalier 37721.*
Mauritius. *Burke in herb. L 955.045—534* (also in G).
Cuba. *Jack 8540.*

Ecology: In dense forests to parklands, usually at medium altitudes (up to 1000 m). *Fl.* (March—)April—May(—Dec.), *fr.* May—Nov.

Uses: Planted as an ornamental tree. Timber of little use. Resin used for lighting (for composition *cf.* Crevost, Bull. Econ. Indo-Chine, Nouv. Sér. 28, 1925, 30). The fruits are still more esteemed than those of *C. album* (see Hance, *l. c.*; Walker *l. c.*).

Notes. Taxonomy. The present species is especially close to *C. album* (same region; for differences see there); moreover, there is some likeness to *C. gracile* (Philippines; very different in its fruits and flowers, and with very widely branched inflorescences and infructescences).

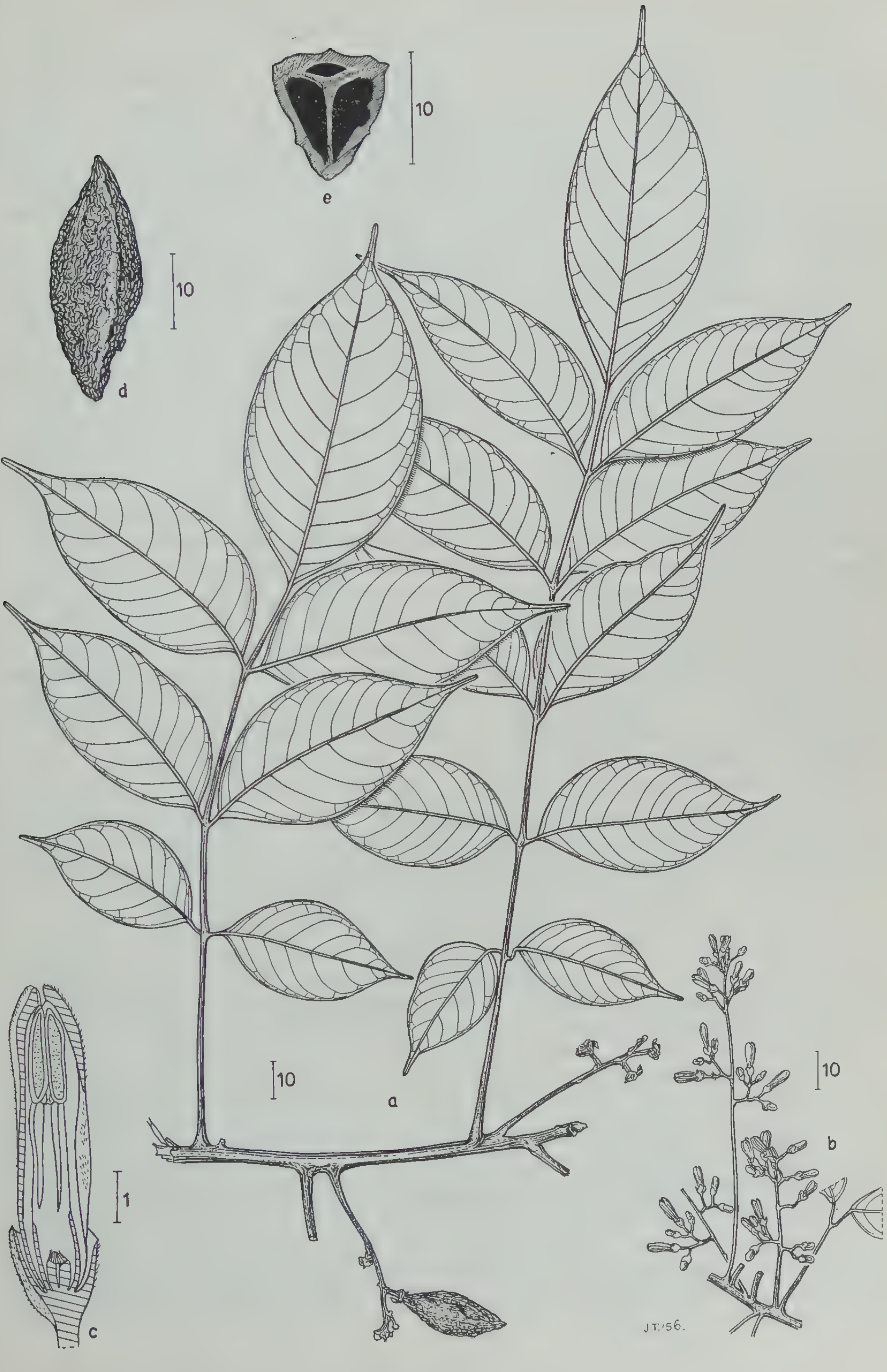
Nomenclature. The conspecificity of Rumphius's *C. sinense Tsjacana* is not quite certain, though probable.

The name *C. pimela* Koen. is illegitimate, as *Pimela nigra* Lour. is mentioned as a synonym (art. 73 Intern. Rules of Nomencl., ed. Stockholm). The correct name should have been *C. nigrum.* In 1814 however, Roxburgh published his *C. nigrum,* which is quite another species. Consequently Engler's name *C. nigrum* (Lour.) is also illegitimate, being a later homonym (1896). As the name *C. pimela* is rather commonly used for the present species, which moreover is a well-known one, cultivated for a long time already on account of its fruits, I deem it desirable to retain this name; in my opinion, this is in accordance with art. 81, and, by basing the new name upon the same type, it is not contrary to art. 74 of the Code.

44. Canarium parvum Leenhouts, *nov. sp.* — *C. tonkinense* (*non* Engl.) Guillaumin, 1911c, 711, *pro parte*; 1946, 678, f. 83^{3-8}, *p. maj. p.* — *Fig. 26.*

Latin diagnosis. Arbor parva. Ramuli c. 4 mm diam., glabri; medulla paucis fasciculis vasorum peripheralibus suffulta. Folia 3—4-jugata, estipulata. Foliola elliptico-ovata, 6½—13 × 3—5 cm, chartacea, supra in costae basim et subtus in nervis omnibus minute pubescentia; basis subobliqua, late cuneata; margo integer; apex subabrupte acuto-acuminata; nervi utrimque 10—12, ad marginem folioli geniculati, nervi apicales conspicue arcuatim conjuncti. Inflorescentiae ♀ axillares, racemosae, 5—7 cm longae, c. 6—7 flores gerentes, glabrescentes. Flores ♀ 5½ mm longi, subglabri. Calyx 3 mm altus. Stamina 6, filamentis pro majore parte connatis. Discus annularis, 1 mm altus, intus et ad marginem longe-pilosus. Pistillum dense pilosum.

Fig. 26. *C. parvum* — a. twig with infructescences; b. ♂ inflorescences; c. ♂ flower in longitudinal section; d. fruit; e. fruit-kernel in cross-section. (a. from *Balansa 3835;* b. from *Pételot 3023;* c. from *Eberhardt 4355;* d—e. from *Bon 3317*) (dimensions in mm).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Type: Tonkin, Tu-Phap, June 1887, *Balansa 3835,* ♀ & fr. (L; isotypes in K, P).

Shrub or small tree, 1—5(—*c.* 14) m high, 15—30 cm diam. *Branchlets* 3—5 mm thick, glabrous with the exception of the minutely velvety terminal bud, sometimes lenticellate; pith with some peripheral vascular strands. *Leaves* (2—)3—4-jugate. *Stipules* none. *Leaflets* ovate to elliptic-ovate (to suborbicular), 4½—8½(—13) by 2—5½ cm, herbaceous to stiff-chartaceous, often slightly pubescent on the base of the midrib above, scattered shortly soft-hairy beneath, specially on the nerves; base slightly oblique, rounded and decurrent to cuneate; margin entire; apex usually abruptly acuminate, acumen ½—1½ cm long, slender, blunt to acute; nerves *c.* 10—12 pairs (angle *c.* 55—75°), faintly curved, geniculate near the margin, apical ones distinctly arching. *Inflorescences* axillary, scattered minutely pilose to nearly glabrous, the ♂ ones narrowly thyrsoid, 4½—9 cm, few-flowered, the ♀ ones racemose, 3—7 cm, with few flowers. *Flowers* ♂ 7—10 mm long, slender, minutely pubescent, ♀ 5½ mm, subglabrous. *Calyx* in ♂ flowers 1½—2 mm, in ♀ ones 3 mm. *Stamens* 6, glabrous, in ♀ flowers minute; filaments in ♂ flowers *c.* 1/3 connate, in ♀ flowers more than halfway connate. *Disk* annular, 1 mm high, in ♂ flowers thick-fleshy, the margin truncate, faintly 6-lobed, ciliate, with a narrow central canal, in ♀ flowers inner surface and margin long-pilose. *Pistil* densely ferruginously hairy, in ♂ flowers absent. *Infructescences* 4—11 cm long, minutely greyish pilose, with 1—4 fruits; calyx 3-lobed, *c.* 5 mm diam., the lobes recurved. *Fruits* spindle-shaped, 3-angular in cross-section, 3—3½ by *c.* 1¼ cm, glabrous; pyrene with 1(—3) blunt (to acute) ribs at every angle, the lids with a faint median rib, and distinctly bordered; lids 1 mm thick, very hard; seeds (1—)2, sterile cell(s) rather strongly reduced.

Distribution: Tonkin and N. Annam.

TONKIN. *herb. d'Alleizette in herb. L 951.54—172; Balansa 3835* (type), *4322; Bon 3317; Eberhardt 4355; Fleury in herb. Chevalier 37685; Lecomte & Finet 398, 648, 674, 689; Pételot 3023, 5838; Prades 11; Service forestier de l'Indo-Chine 25 (Butreau).*
ANNAM. *Poilane 29373* (dubious specimen); *Service forestier de l'Annam 20.*

Ecology: In forests at low altitudes. *Fl.* March—Aug., *fr.* (April—) June—Oct.(—Dec.).

Notes. Apparently related to *C. pimela* and *album*; characterized by its small dimensions, its slender brown twigs, small, distinctly acuminate leaflets with few, strongly curved nerves, and by the absence of stipules.

45. Canarium subulatum Guillaumin, 1908c, 613; 1911c, 715; 1946, 680, f. 84^{6-9}; Leenhouts, 1956, 211 f. 1 i—j. — *C. vittatistipulatum* Guillaumin, 1908c, 612; 1911c, 714; 1946, 680. — *C. cinereum* Guillaumin, 1908c, 612; 1911c, 717. — *C. rotundifolium* Guillaumin, 1908c, 614, t. 19 f. 3; 1911c, 713; Craib, 1926b, 248; Guillaumin, 1946, 680. — *C. thorelianum* Guillaumin, 1908c, 614, t. 19 f. 4; 1911c, 712; 1946, 680, f. 84^{1-5}. — *C. kerrii* Craib, 1911, 26; Guillaumin, 1911c, 716; Craib, 1912, 35; 1926b, 247; Guillaumin, 1946, 680. — *C. album* (*non* Raeusch.) Guillaumin, 1911c, 714, *p. maj. p.* — *C. venosum* Craib, 1926a, 341; 1926b, 248; *non* Guillaumin, 1946, 679 (= *C. littorale*).

Type: S. Cochin-China, Lepoo Mts, March 1866, *Pierre 690c*, ♂, lectotype (P; isotypes in A, BM, L, NY, SING).

Tree, (8—)10—15(—25) m high, 30—60 cm diam., apparently sometimes deciduous. *Branchlets* 4—9(—15) mm thick, fulvous-tomentose when young, glabrescent, leaf-scars strongly prominent; pith with a peripheral cylinder of small vascular strands. *Leaves* 2—5-jugate. *Stipules* more or less caducous, inserted at the conjunction of branchlet and petiole or up to 1 cm on the latter, subulate to filiform, ¾—2½ cm long, tomentose. *Leaflets* broad-ovate to lanceolate, 9—18 by 3½—11 cm, stiff-herbaceous to chartaceous, usually tomentose on midrib and nerves above, densely tomentose on the whole lower surface, rarely glabrescent; base in the basal pair of leaflets equilateral, rounded to cordate, in the higher pairs oblique, upper half rounded, lower half cuneate and decurrent, sometimes, especially in the uppermost pair of leaflets, till the base of the petiolule; margin minutely serrate, dentate or repandous, often with hair tufts; apex gradually acuminate, acumen short, blunt or acute; nervation often more or less waffle-like prominent beneath, nerves 12—20 pairs (angle 55—90°, gradually decreasing from base to apex), straight to faintly curved, geniculate near the margin, in the apical part only more or less distinctly arching; sometimes some intermediate veins well-developed. *Inflorescences* axillary, narrowly laxly thyrsoid (♂) to racemose (♀), scattered pubescent, ♂ ones 7—25 cm long, ♀ ones 8—10 cm. *Flowers* 7—11 mm, minutely pubescent, slender. *Calyx* 2½—3½ mm, faintly lobed. *Stamens* 6, glabrous, in ♂ flowers up to halfway connate, in ♀ flowers small, at least halfway connate. *Disk* fimbriate, in ♂ flowers thick-annular, *c.* 1 mm high, with a narrow central canal or solid, in ♀ flowers annular, *c.* ¾ mm, faintly 6-lobed. *Pistil* in the upper part more or less densely pilose or glabrous, in ♂ flowers usually absent. *Infructescences* 2½—8 cm long, with 1—4 fruits, more or less densely tomentose; calyx saucer-shaped, 6 mm diam., faintly 3-lobed, the lobes often recurved. *Fruits* ovoid, round to triangular in cross-section, 2¾—3½ by 1½—2 cm, scattered pilose to glabrous; pyrene rounded triangular in cross-section, smooth except a faint median rib on the lids; lids 2—3 mm thick; seeds 3(—2), sterile cell slightly reduced.

Distribution: Thailand, Cambodja, Cochin-China; a dubious specimen (*Parkinson 224*) from Mid-Andaman.

THAILAND. Pāyap: *Kerr 605* (syntype *C. kerrii* Craib), *605a* (syntype *C. kerrii* Craib), *3201, 3203, 5405, 5406, 5406 A, 5545; Winits 126.* — Mahārāt: *Suvarnasuddhi 358.* — Pitsanulōk: *Kerr 5729, 8914.* — Udawn: *Akkanitat 17; Din 138; Kerr 5814* (type *C. venosum* Craib); *Lakshnakara 933.* — Rachasima: *Mai Noe 191.* — Prāchinburi: *Collins 403, 1534.* — Rāchaburi: *Kerr 12835, 12835 A.*

CAMBODJA. *Béjaud 733, 782; Mueller 453; Pierre 690f, 690g, 690h, 910* (syntype *C. rotundifolium* Guill.), *4238.*

COCHIN-CHINA. *Chevalier 36724; Harmand 766, 790, s.n.* (syntype *C. rotundifolium* Guill.); *Phung u Dieu 70; Pierre 154* (syntype *C. thorelianum* Guill.), *690a* (syntype *C. cinereum* Guill.), *690b* (syntype), *690c* (lectotype), *690d, 690e* (syntype), *4237* (syntype *C. cinereum* Guill.), *4239* (syntype *C. vittatistipulatum* Guill.), *4239a* (syntype *C. vittatistipulatum* Guill.); *Poilane 181, 17309, 19203, 19517; Thorel 1096* (syntype *C. thorelianum* Guill.).

INDO-CHINA. without exact locality: *Pierre 106* (syntype *C. cinereum* Guill.).

Ecology: Scattered in usually more or less periodically dry, more or less dense to rather open (even savannah-forest), usually deciduous, mixed or dipterocarp forest, at low to rather high alt. (up to 1100 m). *Fl.* March—May(—Oct.), *fr.* May—Aug.(—Sept.).

Uses: The timber is soft and light; it is used for cheap furniture and constructions. The olive-like fruits are eaten.

Notes: The present species is rather variable, especially in its vegetative parts (number, size, and shape of leaflets, pubescence). Though there is some correlation between part of these variations, they are all grading, and it is impossible even to distinguish between some distinct forms. In general, the specimens from the higher parts of Thailand, above *c.* 700 m, are characterized by few-jugate leaves with rather narrow, tomentose leaflets, the base rounded and very oblique, the margin minutely serrate, nervation strongly prominent (*C. venosum*). Specimens from the lower parts of Thailand and part of the Indo-Chinese ones posses more-jugate leaves (especially the Indo-Chinese ones), much broader, less hairy leaflets, with a cordate and less oblique base, with the margin more distinctly incised, and with a less prominent nervation (*C. kerrii* and *rotundifolium*). Typical specimens of *C. subulatum* are very close to *C. venosum*; they differ mainly in their more-jugate leaves with somewhat larger leaflets.

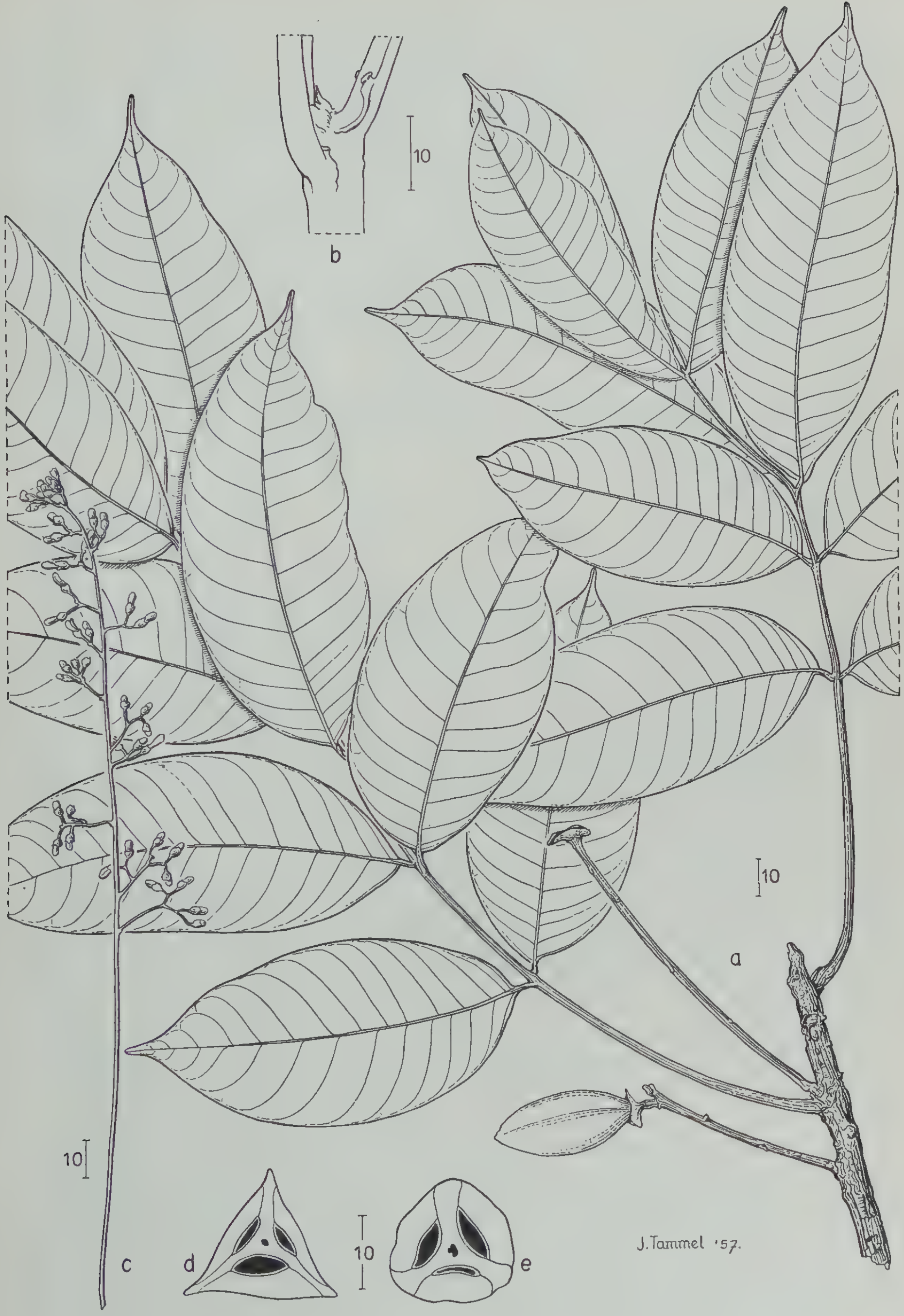
The species as a whole is best characterized by the long and slender flowers, and by the base of the uppermost pair of leaflets, which usually at the lower side is decurrent till the rhachis.

46. **Canarium bengalense** Roxburgh, [1814, 49, *nom. nud.*] 1832, 136; Bennett, 1875a, 534; 1875b, 103; Kurz, 1875, 142; 1877, 209; Gamble, 1878, 15; Engler, 1883, 118; Watt, 1889, 94; King, 1894a, 185, t. 10; Kanjilal *et al.*, 1936, 224. — *Fig. 27.*

Type: India, *W. Roxburgh,* st. (BM). This specimen bears the name 'Canarium bengalense' in Roxburgh's handwriting.

Tree, about 25 m high and 75—120 cm in diam., buttressed. *Branchlets* 1—1½ cm thick, lenticellate, the young parts sparsely and shortly greyish pubescent, the thick terminal bud fulvous pubescent; pith thick, with a closed peripheral cylinder of xylem strands. *Leaves* (6—)9—10-jugate, (sub)glabrous. *Stipules* caducous, inserted on the petiole, 0—8 mm from its base, subulate, *c.* ¾ cm, pubescent; scar prominent. *Leaflets* oblong to ovate, 7—20 by 3—5 cm, chartaceous, sometimes sparsely pubescent on the nerves beneath; base oblique, rounded, in the upper pair of leaflets usually on the lower side decurrent till the base of the petiolule; margin entire or faintly repandous; apex gradually or subabruptly acuminate, acumen ¾—1(—2) cm, rather broad (rarely slender), and blunt; nerves 14—20 pairs (angle variable, usually about 65°), faintly curved, more strongly so towards the margin, at least the apical ones distinctly arching; intermediate veins sometimes well-developed. *Inflorescences* (♀ unknown) axillary, narrowly thyrsoid, 30—40 cm long, subglabrous;

Fig. 27. *C. bengalense* — a. twig with infructescences; b. bases of petioles with stipule-scars; c. ♂ inflorescence; d—e. cross-sections of fruit-kernels. (a. and e. from *Peal 317;* b. and d. from *Poilane 1858;* c. from *Macalpine s.n. in herb. DD 59852*) (dimensions in mm).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branches 3—4 cm long, laxly rebranched, with up to *c.* 7 flowers. *Flowers* (♀ unknown to me, described after Roxburgh, *l. c.*) 7 mm, nearly glabrous. *Calyx* 2 mm. *Stamens* 6, glabrous, connate for about half the length of the filaments. *Disk* in ♂ flowers tubular, 1½—1¾ mm high, margin and inner surface densely pilose by stiff erect hairs, in ♀ flowers annular, 3-lobed, fimbriate. *Pistil* in ♂ flowers minute, densely tomentose. *Infructescences* axillary, racemose, 5—9 cm, scurfy, with 1—3 fruits at the apex; calyx saucer-shaped, 3-lobed, 1 cm diam. *Fruits* spindle-shaped, acute at apex, triangular to circular in cross-section, 4½—5 by 1¾—2 cm, glabrous; pyrene acute (to blunt) triangular in cross-section, the angle-ribs sometimes prominent, lids with a faint median rib; lids 1½—3 mm thick; seed(s) 1—2, the sterile cell(s) moderately to strongly reduced.

Distribution: Bengal, Assam, Burma, Thailand, and Indo-China (Laos).

BENGAL. *Dent in herb. DD 56489; Macalpine in herb. DD 59852.*

ASSAM. *Griffith 658 (= Kew distr. 1144); Peal 265, 281, 317; Punkayastha & Toshat 3; Kanjilal 1631, 4966, 5354.*

BURMA. *Sukoe 7612.*

THAILAND. Chantaburi: *Lakshnakara s.n.*

LAOS. *Poilane 1858.*

without locality: *Smith 447.*

Ecology: In evergreen, moist, mixed forests, usually at medium alt. (370—1000 m). *Fl.* (Jan.—)May—July, *fr.* (June—)Nov.—Jan.

Wood anat.: See Gamble, Man. Ind. Timb., 1881, 68.

Uses: The timber is used for tea-boxes and for shingles; it is also in use for construction. The brittle and amber-coloured resin is used as incense; when mixed with bees wax, it is also a good substitute for shellac for use in stiffening crêpe (see Cooke, Rep. Gums, Resins, *etc.* in the India Museum, 1874, 97; for analysis: Hooper, Agric. Ledger *no.* 3, 1908, 49). In native medicine the leaves and bark are used externally for rheumatic swellings. Fruits edible.

Notes. Morphology. The specimen *Henry 13171* from S. Yunnan probably belongs to this species; if so, it would present a valuable link between the Laos specimen and the main part of the area. It differs in some points, chiefly by the large number of nerves (22—24 pairs), which are very dense, the distinctly transverse veins, and the blunt-triangular, truncate fruits.

Taxonomy. Related to *C. strictum* and *subulatum*. Mainly characterized by the large number of leaflets, and by the usually acutely triangular fruits; moreover, the two latter species are usually distinctly more hairy.

47. Canarium strictum Roxburgh, [1814, 49, *nom. nud.*] 1832, 138; Wight & Walker-Arnott, 1834, 175; Walpers, 1842, 558; Dalzell & Gibson, 1861, 52; Beddome, 1871, t. 128; 1872, t. 181; Bennett, 1875a, 534; Engler, 1883, 118; Lubbock, 1892, 333, f. 237, *sp. uncertain*; King, 1894a, 186, t. 13; Cooke, 1902, 202; Gamble, 1915, 172; Talbot, 1949, 103. — *Rhus dhuna* Buchanan-Hamilton *ex* Wallich, 1847, *no.* 8502, *nom. nud.* — *Pimela stricta* Blume, 1850, 226. — *C. sikkimense* King, 1894a, 187, t. 11, 12. — *C. reziniferum* Brace *ex* King, 1894a, 188; Kanjilal *et al.*, 1936, 224.

Type: *Hort. Bot. Calcutta s. n.*, introduced from Tinnevelly, S. India, lectotype (BM).

Tall, buttressed tree, up to 50 m by 150 cm. *Branchlets* ½—2½ cm diam., often rather gnarly, usually densely ferruginously woolly when young, gradually more or less glabrescent; pith with a peripheral cylinder of vascular strands and a number of scattered ones. *Stipules* nearly always absent, if present very caducous, inserted at the conjunction of petiole and branchlet, subulate, about 7 mm, densely woolly pubescent. *Leaves* 3—5 (in young specimens up to 7)-jugate, pubescence very variable. *Leaflets* short-stalked, ovate to elliptic, 10—20 by 4—10 cm, thin- to stiff-coriaceous, glabrous above, subglabrous to rather densely, ferruginously tomentose beneath; base oblique, subcordate or rounded to broadly cuneate, usually slightly decurrent, sometimes in the basal half of the upper pair of leaflets decurrent to the very base of the petiolule; margin faintly undulate to slightly (in young specimens distinctly) dentate; apex gradually to more or less abruptly acuminate, acumen ½—1 cm, blunt to acute; nerves 12—22 pairs (angle 60—80° near the base, 50° near the apex), nearly straight (except some strongly sinuous basal ones), usually abruptly and distinctly arching near the margin. *Inflorescences* axillary, sometimes together pseudo-terminal, narrowly thyrsoid (♀ sometimes racemose), densely ferruginously woolly to minutely fulvous-tomentose, more or less glabrescent, ♂ ones 15—40 cm, the flowers in short-stalked, rather many-florous glomerules, ♀ 7—20 cm, few-flowered, the branches with up to 3 flowers. *Flowers* ♂ 7 mm, ♀ 9 mm. *Calyx* subglabrous to ferruginously woolly outside, ♂ 4 mm, ♀ 5½ mm, both with short blunt lobes. *Petals* outside subglabrous to densely appressedly pubescent. *Stamens* 6, glabrous, in ♀ flowers episepalous ones slightly longer than epipetalous ones; filaments connate for ¼—¾ their length; anthers distinctly acuminate. *Disk* long-pilose on margin and inner surface, ♂ annular, 1 mm high, ♀ faintly 6-lobed, ½ mm high, fleshy. *Pistil* glabrous or with some scattered appressed hairs; in ♂ flowers (nearly) absent. *Infructescences* racemose, 10—20 cm, glabrous, with 1—3 rather long-stalked fruits; calyx saucer-shaped, faintly 3-lobed to 3-angular, 1¼ cm diam. *Fruits* obovoid to ellipsoid, nearly circular to rounded triangular in cross-section, blunt at base and apex, 3¼—4½ by 1¾—2¼ cm, (sub)glabrous; pyrene smooth, angle-ribs blunt, the lids with a faint to distinct median rib each; lids 2½ mm thick; fertile cells 1(—2), sterile ones faintly (to strongly) reduced.

Distribution: S.W. Deccan, Sikkim, Assam, and Upper Burma.

S.W. DECCAN. *Anglade 19, in herb. CAL 78206; Barber 5724; Beddome 214, 274, 1097, 1098, 1099, 1100, 1101; Bell in herb. Sedgwick & Bell 5991; Bourdillon 925; Bourne 820; Gibson in herb. CAL 78202/3; Hallberg & Mc Cann in herb. BLAT 35046; Law 59; Sauliere 546; Stocks in herb. CAL 78210; Talbot 1228, 1879, 2731; herb. DD 27017—9.*

SIKKIM. *Kari 4030; King s.n.* (lectotype *C. sikkimense* King).

ASSAM. *Kanjilal 5595; Mann s.n.* (lectotype *C. reziniferum* King), *s.n.* (syntype *C. reziniferum* King); *Masters in herb. L 898.319—366; Rowbotham in herb. DD 48571; herb. DD 48865.*

cultivated: *Anderson 28; Hort. Bot. Calcutta,* div. specimens (type); *Pierre 4240.*

localities unknown: *Hohenacker 578; Wight 208 (= Kew distr. 405), in Wallich 4888; NN. 2258; herb. CAL 78204, 78209.*

Dubious specimens: (mostly young shoots or suckers).

S.W. DECCAN. *Ambo in herb. Sedgwick & Bell 7198; Bourne 16 R; Gamble 15501, 18253, 18253a; Wight & Arnott 538; herb. DD 29397.*

ASSAM. *Hamilton 824; Macalpine R 1; Rowbotham in herb. DD 48570; herb. DD 49936.*

UPPER BURMA. *Dent 37.*

cultivated: *Raizada in herb. DD 89270.*

locality unknown: *herb. CAL 78211.*

Ecology: In evergreen, moist hill-forests, from sealevel to about 1600 m (apparently preferably at about 500 m). *Fl.* Dec.—July, *fr.* Sept.—March. M. C. Cooke, Rep. on Gums, Resins etc., 1874, 95, describes and figures the combs which the bee *Trigona laeviceps* makes from a mixture of the resins of this and some other trees. This "wax" is known in commerce as *pwê-nyet* (or: *poon-yet, pwai-nget*).

Uses. The wood is soft and of little use. The resin is black (in thin plates amber-coloured) and is used locally for many purposes (see Beddome, 1871, *l. c.*; M. C. Cooke, *op. cit.*, 93 & 95; A. W. Bennett, 1875b, 103; G. Watt, Dict. Econ. Prod. India 2, 1889, 96; D. Hooper, Agric. Ledg., 1908, no. 3, 47; Guillaumin, Agric. Prat. Pays Chauds 9(2), 1909, 48).

Notes. Morphology. The tree is probably usually deciduous (though this is only rarely reported), as the beautiful crimson colour of the tree in young foliage is often mentioned.

This species is a rather variable one. Part of the northern specimens (among which the types of *C. sikkimense* and *reziniferum*) posses rather large, coriaceous leaflets, slightly cordate at base, with a distinctly incised margin, and beneath with a very prominent nervation and a dense, ferruginous tomentum; the branchlets of these specimens are very coarse, the pubescence is dense and long, and remains for a long time, and the ♂ inflorescences are large, more loosely branched, and many-flowered. There seems to be, however, a gradual transition between these and the other, less coarse, specimens; moreover the flower- and fruit-characters are within the same narrow variability. As far as I can see (the material is rather incomplete, many specimens are very insufficient), even the large geographical gap does not coincide with any clear morphological boundary.

In my opinion, this species is closely related to both *C. bengalense* (differing by more-jugate leaves, entire leaflets, larger and more widely branched inflorescences, and acutely triangular fruits) and *C. euphyllum* (pith of branchlets without vascular strands, leaves coarse and glabrous, disk in ♂ flowers nearly glabrous, fruits much smaller and with 1 fertile and 2 strongly reduced cells).

Nomenclature. The type-specimen of *C. strictum* consists of one leaf of a young tree only, and is very poor indeed. Moreover, this tree apparently did not come to maturity, and so Wight & Arnott, 1834, *l. c.*, cite: "Introduced into the Botanic Garden of Calcutta, where it does not appear to have flowered. We consider it a very doubtful species." The reasons, why I nevertheless retain the name, are that in my opinion there is only one — though a very variable — species of *Canarium* in Southern India, and that complete specimens are available, collected in the type-region by Beddome (his nrs. *1097* & *1098*).

48. Canarium euphyllum Kurz, [1870, 33 & 67, *nom. nud.*] 1872, 295; Bennett, 1875a, 535; 1875b, 103; Kurz, 1877, 208; Engler, 1883, 123; Prain, 1891, 306; 1893, 68; King, 1894b, 241; Parkinson, 1923, 115. — *Fig. 28.*

Type: S. Andaman, Port Mouat, ridge in centre, *Kurz in herb. CAL 78235*, ♂ (CAL; isotypes in CAL, K, P).

Rather large, evergreen or deciduous tree, up to *c.* 30 m high (Burma spec. 40 m), diam. *c.* 60(—100) cm, with small buttresses. *Branchlets* 1½ cm thick, glabrous except the ferruginous shaggy-pilose terminal bud, leaf-scars very conspicuous, though not prominent, cordate, *c.* 1½ by 1½ cm, smooth; pith with a compressed peripheral cylinder of vascular strands. *Leaves* 4—6(—8)-jugate, glabrous. *Stipules* absent. *Leaflets* ovate to oblong, 10—25(—35) by 5—9 cm (basal pair much smaller), chartaceous; base oblique, rounded to subcordate; margin coarsely serrate or dentate, rarely entire; apex abruptly acuminate, acumen short, acute; nerves 12—19(—*c.* 30) pairs (angle 65—80°), straight to faintly curved, abruptly, often indistinctly, arching close to the margin; intermediate veins often strongly developed. *Inflorescences* (♀ unknown) axillary, narrowly thyrsoid, 20—45 cm long, (sub)glabrous; the branches transverse, up to *c.* 4 cm long, with 4—6 flowers; *bracts* subulate. *Flowers* (♂) 1 cm, minutely tomentose. *Calyx* 4½ mm. *Stamens* 6, glabrous, the filaments about halfway connate. *Disk* annular, 1—2 mm high, fleshy, glabrous, with a narrow central canal. *Pistil* minute to none, glabrous. *Infructescences* racemose, 10—20 cm, rather coarse, with 3—5 fruits; calyx saucer-shaped, 3-angular, 1 cm diam., with the remains of a 6-lobed, fimbriate disk. *Fruits* ovoid-ellipsoid, rounded triangular in cross-section, 2½ by 1¼ cm, glabrous, verrucose; pyrene rounded triangular in cross-section, smooth; lids 1—1½ mm thick. *Seed* 1; sterile cells moderately reduced.

Distribution: Burma, Andamans, and Nicobar Islands.

BURMA. Bhamo distr.: *Maung Mya 3699.*

ANDAMANS. Great Coco Isl.: *Prain in herb. CAL 78240/1.* — Baratang Isl.: *Osmastri 9.* — S. Andaman: *Dep. Cons. Andamans in Imperial Forest Coll. herb. 1246; King in herb. CAL 78239; King's coll. 342, in herb. CAL 78233/4; Kurz in herb. CAL 78235* (type). — without exact locality: *Bradley B 5829, in herb. DD 27539; Hildebrand 12; Kirat Ram 3665; Parkinson in herb. DD 8649.*

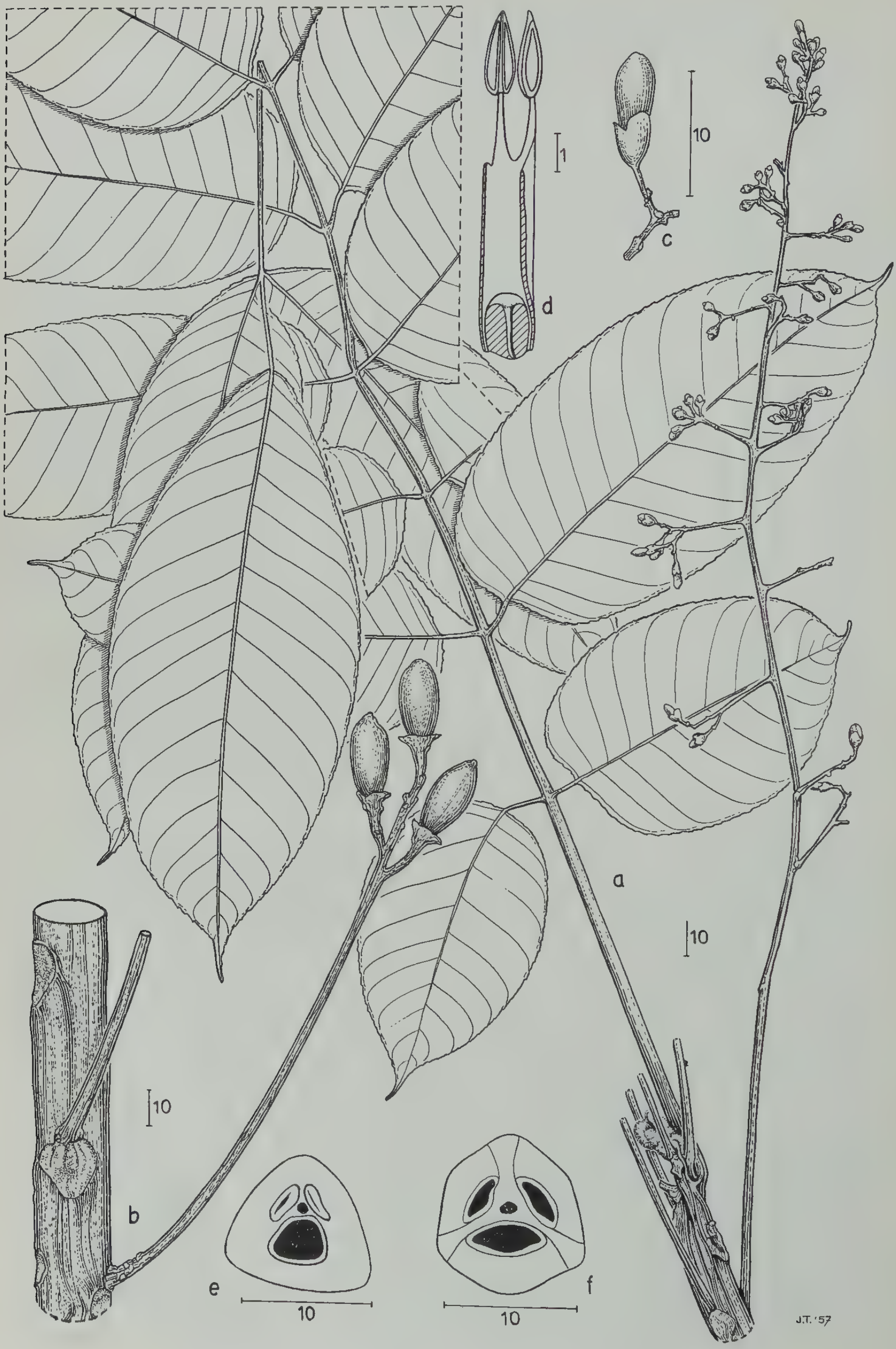
NICOBAR ISLANDS. Car Nicobar: *Heinig in herb. CAL 78242.* — Great Nicobar: *Chengappa 23034.*

Ecology: A common species in the jungle at low alt. (Burma up to 850 m). *Fl.* May—June, *fr.* Febr.—May.

Wood anat.: See Rendle, Commercial Mahoganies and allied Timbers, 1938, 27; Handb. Empire Timbers, 1945, 37.

Uses. Logs sometimes used as floats for rafting timber. Timber (*Indian white mahogany*) used for matches, boxes, planks, and indoor constructions. Resin (*dhup*) used for burning and for binding arrows.

Notes. Morphology. The specimen *Maung Mya 3699*, the only one from Burma seen by me, is in many characters slightly different from those of the Andamans and Nicobars (leaflets smaller, *viz.* 8½—14 by 4½—5 cm, coriaceous, slightly pilose beneath; lower side of the base in the upper pair of leaflets decurrent up to the rhachis; margin minutely dentate; fruits distinctly 6-angular in cross-section, the fertile cell smaller,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the sterile ones less reduced); probably it deserves subspecifical status, but on account of the very insufficient material I do, for the time being, not care to distinguish it taxonomically.

Though Kurz mentioned caducous subulate stipules in the present species, I could not trace them in any of my specimens.

Taxonomy. A very distinctive species, apparently related to *C. bengalense* and *strictum*, both Indian and Burmese.

Geography. Apparently the most widely spread *Canarium* species of the Andaman Islands (moreover the only species known from the Nicobar Islands), and the only one with a continental Asiatic relationship. Both these facts point at an old relationship between the Andaman and Nicobar Islands and Burma, older than the Sumatran relationship.

49. Canarium intermedium H. J. Lam, 1932a, 213, t. 11 f. 76, t. 13 f. 104b; 1932b, 482; Leenhouts, 1956, 285. — *Fig. 29.*

Type: Sumatra, G. Kaba, Ayer Angat, alt. 660 m, 1881/'2, *Forbes 2875*, ♀, lectotype (BO; isotypes in BM, FI, L).

Tree *c.* 35 m by 50—85 cm. *Branchlets c.* 9 mm thick, soon glabrescent; pith with many vascular strands, part of them peripherally arranged. *Stipules* absent. *Leaves* 3—6-jugate. *Leaflets* lanceolate, 4—12 by 2—3½ cm, chartaceous, glabrous; base rather oblique, broadly cuneate; margin entire; apex gradually, shortly and broadly blunt-acuminate; nerves 10—12 pairs (angle 50—60°), straight to faintly curved, gradually and distinctly arching at 1½—2 mm from the margin. *Inflorescences* (♂ unknown) axillary, narrowly thyrsoid, 11—18 cm, soon glabrescent; main branches up to 4½ cm, often with only one well-developed flower. *Flowers* (♂ unknown) 7 mm, glabrous. *Calyx* 4—6 mm high. *Stamens* glabrous, 3—3½ mm long, filaments almost wholly connate, sometimes with interstaminal teeth. *Disk* minute, annular, pilose. *Pistil* glabrous, stalked. *Infructescences c.* 15 cm, with 2—3 fruits, glabrous; calyx flat, 3-angular, 11 mm diam. *Fruits* elliptic, faintly trigonous in cross-section, *c.* 3 by 2 cm, apparently containing 2 *seeds*; sterile cell not very reduced.

Distribution: S. Sumatra.

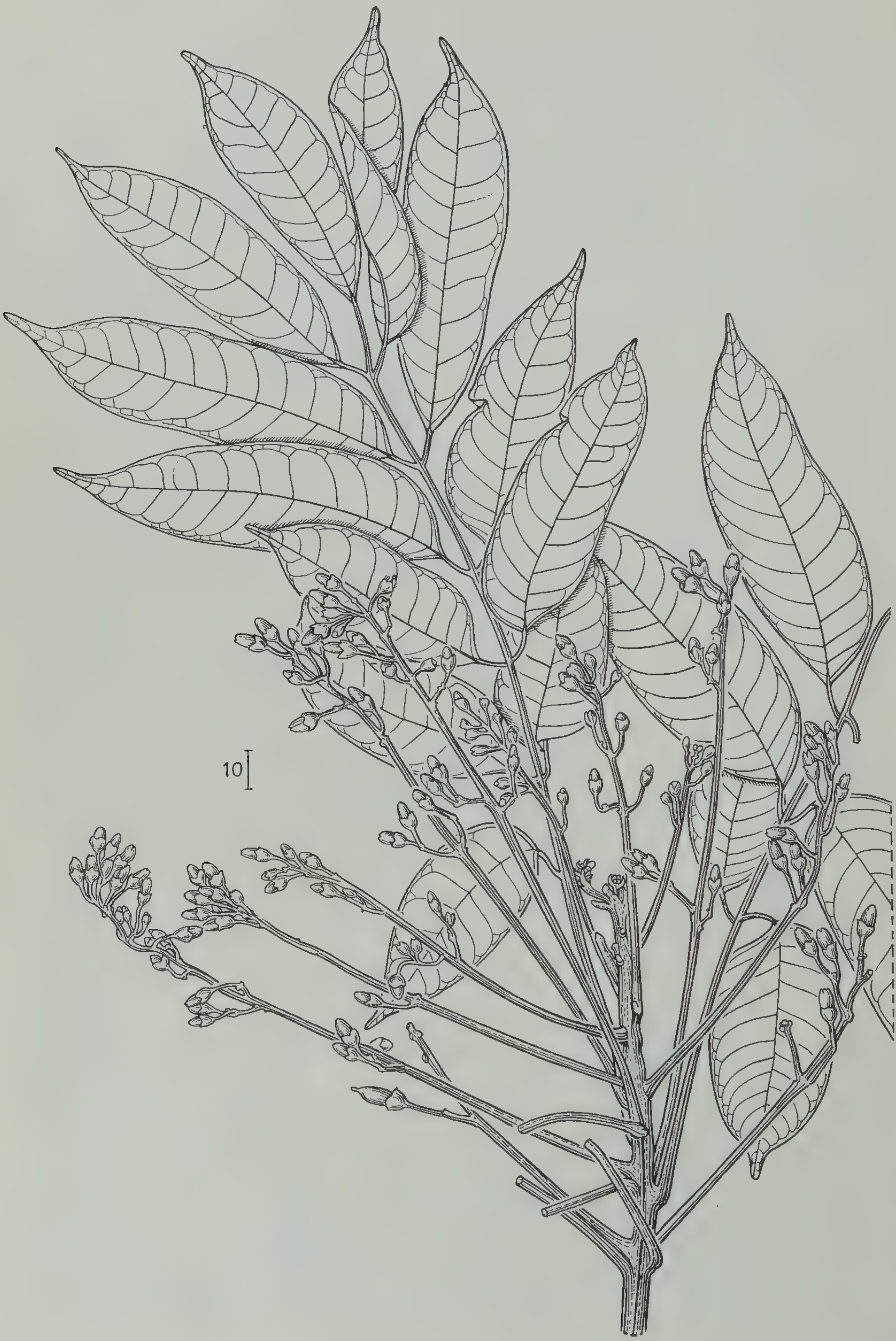
SUMATRA. *Forbes 2875* (lectotype); *FRI. bb. 8692* (syntype).

Ecology: In forest, 600—900 m.

Note. This species is closely related to *C. kipella* from W. Java.

50. Canarium kipella (Bl.) Miquel, 1859, 646; Engler, 1883, 129; Koorders & Valeton, 1896, 41; Backer, 1911, 197; Koorders, 1912, 433; Lam, 1932a, t. 13 f. 104d, t. 15 f. 117c; 1932b, 480, t. 11 f. 73; 1948, 6; Leenhouts, 1956, 285. — *C. pimela* (*non* Koen.) Blume, 1826, 1162. — *Pimela kipella* Blume, 1850, 220. — *Pimela kitengo* Blume, 1850, 221. — *C. kitengo* Miquel, 1859, 647; Engler, 1883, 148; Koorders & Valeton, 1896, 46; Backer, 1911, 199; Koorders, 1912, 433.

Fig. 28. *C. euphyllum* — a. twig with ♂ inflorescence; b. older twig with infructescence; c. ♂ flower; d. ditto, longitudinal section of staminal tube and disk; e. and f. cross-sections of fruit-kernels. (a. from *herb. CAL 78228,* the inflorescence and c. and e. from *Imp. For. Coll. herb. 1246;* b. and e. from *Kirat Ram 3665;* f. from *Maung Mya 3699*) (dimensions in mm).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Type: Java, *Blume (?) in herb. L. 898.319—296,* ♂ (L).

Tree, 25 m, with small buttresses. *Branchlets* c. 8 mm thick, lenticellate, young parts densely ferruginously woolly tomentose; pith with many vascular strands, sometimes arranged into 1 or more concentric cylinders. *Stipules* (nearly?) always absent. *Leaves* 4—8-jugate. *Leaflets* oblong-lanceolate, 7—16 by 2½—5(—6) cm, thinly chartaceous, glabrous; base often oblique, cuneate to truncate; margin entire; apex gradually shortly (*c.* 1 cm), broadly, and bluntly acuminate; nerves 14—17 pairs (angle 60—70°), faintly to strongly curved, gradually, often rather distinctly, arching at 1 mm from the margin. *Inflorescences* axillary, narrowly thyrsoid, densely woolly pubescent, glabrescent, ♂ ones 9—27 cm long, ♀ ones 7—15 cm; partial panicles about decussate, patent, rather long-stalked, ♂ ones up to 4—5 cm long, with up to 12 flowers, ♀ ones 2½ cm long, with 8—10 flowers. *Flowers* 7—8 mm long, slightly pubescent outside. *Calyx* ¼ cm high, nearly truncate. *Stamens* glabrous, 6—7 mm long, connate for 3—4 mm. *Disk* pilose, in ♂ flowers subglobose, 1½—2 mm high, with a central canal, in ♀ flowers cupular, 1 mm high, 6-undulate. *Pistil* glabrous, in ♂ flowers absent. *Infructescences* up to 20 cm long, thinly pilose, branches with 1 fruit only; calyx spreading, ½ cm diam. *Fruits* ovoid, round in cross-section, 2½—3¼ by 1—1½ cm, glabrous; pyrene ± 6-angular; lids rather thick. *Seeds* 1—2; sterile cell(s) often very reduced.

Distribution: W. Java (Mt Salak; Palabuanratu).

JAVA. *Blume in herb. L 898.319—297* (syntype *Pimela kipella* Bl.), *in herb. L 898.319—293, 295, 296* (type *Pimela kipella* Bl.), *in herb. L 898.319—299, 908.352—967* (type *Pimela kitengo* Bl.); *Hort. Bot. Bog. VI B 67; Koorders (β-numbers) 3035, 12256, 33083; NN. s.n. in herb. L. 898.319—298.*

Ecology: In hill (?) forests, apparently a rare species. *Fl.* April—May, *fr.* May.

Wood anat. Moll & Janss. Mikr. 2 (1908) 108.

Note. Closely related to *C. intermedium.*

51. Canarium australianum F. von Mueller, 1862, 15; Lam, 1932b, 529; White, 1936, 55; Leenhouts, 1956, 284, f. 44. — *C. australasicum* F. von Mueller *ex* Bentham, 1863, 377; Engler, 1883, 120; Jadin, 1894, 88, f. 43; Engler, 1896, f. 136 J—P; 1931, f. 211 J—P; Bailey, 1898, 31; Guillaumin, 1909a, f. 22^{17}; White, 1922, 38; *non C. australasicum* Leenhouts, 1952, 159, *quae est C. baileyanum* Leenh. — *Sonzaya australiana* Marchand, 1868, 27, 64, t. 5.

Type: Australia, Queensland, Sweer's Island, *Henne s. n.*, ♀ & fr., lectotype (BR).

Tree, 20(—30) m by 45 cm. *Branchlets* c. 1 cm thick, young parts shortly ferruginously pubescent; pith with many small vascular strands, for the greater part (rarely all of them) peripherally arranged. *Stipules* caducous, inserted at the base of the petiole, rarely on the latter up to 11 mm from the base, subulate, 7—15 mm. *Leaves* 3—4(—6)-jugate. *Leaf-*

Fig. 29. *C. intermedium,* twig with ♀ inflorescences. (*FRI. bb. 8692*) (dimensions in mm). *del.* J. Tammel.

lets ovate, 7—11(—17) by 3—7 cm, thinly coriaceous, glabrous or minutely tomentose beneath; base rounded to truncate, rarely cuneate or cordate, slightly oblique, in the apical pair of leaflets the lower leaflet-half mostly decurrent to the base of the petiolule; margin entire or slightly dentate; apex rounded to acute, sometimes truncate or shortly and broadly blunt-acuminate; nerves 15—24 pairs (angle mostly 75—80°), straight to slightly curved, often tortuous, rather abruptly distinctly arching at some distance from the margin. *Inflorescences* axillary, narrowly thyrsoid, fulvous tomentose; ♂ ones *c.* 25 cm long, ♀ ones 8—15 cm; branches up to 3 cm, ♂ ones with *c.* 12 flowers, ♀ ones with 3—4 flowers. ♂ *Flowers* 4—5 mm long, ♀ 6½ mm. *Calyx* respectively 2½ and 3½ mm high. *Stamens* glabrous, connate, in ♂ flowers for about half the length of the filaments, in ♀ flowers almost wholly. *Disk* in ♂ flowers truncate, deeply 6-grooved, ¾ mm high, with a central canal, outside glabrous, upper surface and inside densely woolly pubescent; in ♀ flowers annular, ¾ mm high, 6-lobed, glabrous. *Pistil* tomentose, in ♂ flowers nearly totally reduced. *Infructescences* up to 18 cm long with up to 5 fruits; calyx spreading, 3-angular, 9—10 mm diam. *Fruits* ovoid, round to rounded-triangular in cross-section, *c.* 2 by 1¼ cm, glabrous; pyrene rugulose, faintly 3-ribbed to the apex; lids 2 mm thick. *Seed* 1; sterile cells rather strongly reduced.

Distribution: S.E. New Guinea (Wassi Kussa, Mabaduan, Pt Moresby) and N. Australia (N.E. Queensland and Arnhem's land).

Taxonomy. Two varieties can be distinguished:

a. var. **australianum.**

Leaflets densely short-tomentose beneath.

Distribution: As the species.

NEW GUINEA. *White 52.*

AUSTRALIA. *Cunningham 170.* — Queensland: *Bailey 396; Bancroft 33; Blake 15137; Brass 2044; Cunningham 60; Flecker 1107; Haines 156 Q; Illingworth 63; Kajewski 1319; Mac Gillivray 93; Merrotsy 39; Roth 288; Stuart 51; Warburg 19174.* — Arnhemsland: *Brown 5425a; Specht 978, 1074 (a).*

b. var. **glabrum** Leenhouts, 1955b, 189; 1956, 285.

Type: Australia, Northern Territory, Gulf of Carpentaria, Bickerton Island, South Bay, June 15, 1948, *Specht 571*, fr. (L; isotypes in K, LAE).

Leaflets fully glabrous.

Distribution: As the species.

NEW GUINEA. *Brass 6561, 8425* (paratypes)

AUSTRALIA. Queensland: *Brass 2005* (paratype); *Hill 94; Michael 1360* (paratype); *Stephenson 700; Thomson 18* (paratype); *Thurston 268 (Flecker 3819)* (paratype); *White 11682* (paratype). — Arnhem's land: *Brown 5425* (paratype); *Prager 28* (paratype); *Schomburgk 116; Schultz 586; Specht 571* (type), *1074* (paratype).

Ecology: In Papua only found in rain-forest (Mabaduan) and in monsoon-forest (Wassi Kussa), in Australia also in more open forests on rather dry, sandy soil, and on coastal, sparsely timbered dunes, always at low altitudes; apparently restricted to regions subject to a periodically dry period. *Fl.* Nov.—April, *fr.* (mainly) April—June.

Uses. In Australia, tin fossickers and miners are said to prefer the wood of this tree above all others available for making pick- and axe-handles. The resin is used by the aborigines for spear fastening.

Notes. The species is apparently related to *C. pilosum*; it is, however, quite distinct in many characters, especially in its leaflets, which look more or less like those of *C. decumanum* and of some species of sect. *Canariellum*. Among the Australian species it is the only one with stipules.

According to Whitehouse (*in sched.*), the fruits are eaten by birds, especially by Torres Strait pigeons.

52. Canarium dichotomum (Bl.) Miquel, 1859, 648, *incl.* also *var. lucidula*; Engler, 1883, 141; Lam, 1929, 116; 1932b, 447, t. 9 f. 57; Leenhouts, 1956, 283, f. 22b. — *Pimela dichotoma* Blume, 1850, 222. — *C. endertii* Lam, 1932a, 210, t. 15 f. 117a; 1932b, 450, t. 10 f. 60; 1936, 17.

Type: Sumatra, *Korthals 957*, ♂ (L; isotype in U).

Tree, 15—32 m by 15—60 cm, rarely shrub-like and up to 7 m high; buttresses up to 1½ m high. *Branchlets* ½—2 cm thick, glabrescent; pith with a peripheral cylinder of minute vascular strands. *Stipules* caducous to persistent, inserted at the base of the petiole or slightly on the latter, subulate to linear, often abruptly broadened at base, ½—1½ cm. *Leaves* 3—5(—8)-jugate, glabrous. *Leaflets* ovate to oblong, 5—25(—36) by 2½—9(—13½) cm, chartaceous to coriaceous; base oblique, rounded to broadly cuneate; margin entire; apex gradually to subabruptly blunt-acuminate, acumen rather short and broad (—1½ by ½ cm); nerves 9—18 pairs (angle variable), straight to slightly curved, gradually, mostly distinctly, arching close to the margin. *Inflorescences* terminal, sometimes some additional axillary ones in the uppermost leaf-axils, laxly thyrsoid, glabrous, ♂ ones 19—42 cm long, many-flowered, ♀ ones 6—25 cm, with few flowers, axes dark red (*statu vivo*); main branches in ♂ inflorescences repeatedly dichotomous, up to 25 cm long, in ♀ ones not distinctly dichotomous, up to 6(—20) cm, flowers in cymules. *Flowers* (nearly) sessile, 6—9(—12) mm long, sometimes (even ♂ ones) with a slightly concave receptacle (best developed in the large-flowered, coarse Borneo-specimens), glabrous outside. *Calyx* 5—8 mm high. *Stamens* glabrous, in ♂ flowers confluent at the base, in ♀ flowers connate for the greater part; thecae in ♂ ones distinctly acuminate. *Disk* 1 mm high, in ♂ flowers cupular to flattened, pilose within, in ♀ flowers annular, faintly 6-undulate, minutely tomentose, margin fimbriate. *Pistil* in ♂ flowers much reduced, pilose; in ♀ flowers glabrous, sometimes with a 1 mm high pseudo-gynophore. *Infructescences* up to 40 cm long, main branches up to 17 cm, with 1—2(—10) fruits; calyx funnel-shaped, trigonous, 8—10 mm diam. *Fruits* narrowly oblong, acute at both ends, trigonous in cross-section, 2¾—4 by 1—2 cm, glabrous; pyrene acutely to rounded triangular; lids rarely with a median rib, 1½—2 mm thick. *Seeds* 1—2, sterile cells moderately reduced.

Distribution: Sumatra, Borneo.

SUMATRA. *Dumas 1561; Forbes 2742; FRI. bb. 26047; Korthals 957* (type); *Lambach 1350; Lörzing 4622; Meijer 3190; Teysmann HB 687* (type *C. dichotomum var. lucidula* Miq.).

BORNEO. *Amdjah 259; Clemens 21537; Elmer 20231; Endert 3316* (syntype *C. endertii* H. J. Lam); *FRI. bb. 11769 (v. d. Zwaan 414)* (syntype *C. endertii* H. J.

Lam), *bb. 11939* (syntype *C. endertii* H. J. Lam), *bb. 14651, bb. 20703 (Henar 128), bb. 29418; Kostermans 5525, 5527, 6534, 7283a; NBFD. 2963 (Caguiela), A 1322 (Cuadra), SAN 15161 (Wood); Omar 101; Ramos 1807; Richards 1382, 1487; Villamil 257; 5953 = Sarawak herb. 21537.*

Ecology: In primary forests on dry grounds; altitude up to 1200 m. *Fl.* mainly June—Aug., *fr.* (mainly) Sept.

Uses. The resin is clear and is said to be useful.

Notes. A rather variable species. At first sight it seemed possible to distinguish between a coarse form, mainly collected in Borneo and representing *C. endertii* H. J. Lam, and a more slender form, comprising the Sumatra specimens, which is *C. dichotomum* Miq. *sensu stricto.* Typical specimens of *C. endertii* differ from typical specimens of *C. dichotomum* by their glabrescence, by more lingulate, persistent stipules inserted on the petiole, larger inflorescences and flowers, and ♀ flowers with a concave receptacle. As there are intermediates in various degrees an acceptable demarcation of two taxa is rendered impossible.

The species is best characterized by the rather large, broadly paniculate inflorescences and infructescences, both not very dense, the latter with slender, triangular fruits.

53. **Canarium fusco-calycinum** Stapf *ex* Ridley, 1930, 82; Lam, 1932b, 449, t. 9 f. 58; Leenhouts, 1956, 283.

Type: Borneo, Sarawak, near Kuching, Dec. 7, 1892, *Haviland 1981,* ♂ (K; isotypes in BM, SAR).

Tree. *Branchlets* slender, minutely villous; pith with peripheral vascular strands. *Stipules* caducous, inserted at the base of the petiole, linear, 7 by 2 mm. *Leaves* 1—2(—3)-jugate. *Leaflets* ovate to oblong, 2—25 by 1½—12½ cm, stiff chartaceous, glabrous above except on the midrib, more or less densely pubescent beneath; base broadly cuneate to faintly cordate; margin entire; apex rounded, abruptly shortly and broadly to long, slender and acutely acuminate; nerves 10—24 pairs (angle 55—65°), faintly curved, geniculate near the margin, sometimes (in large leaflets) distinctly arching. *Inflorescences* (♀ unknown) terminal, pyramidal-thyrsoid, up to 40 by 30 cm, villous, many-flowered; main branches up to 20 cm, broadly thyrsoid. *Flowers* (♀ unknown) subsessile, buds ovoid, closed, 9 mm long. *Stamens* connate for greater part. *Disk* cupular, small, erectly pilose, without rudimentary pistil. *Infructescences* and *fruits* unknown.

Distribution: Borneo (Sarawak).

BORNEO. *Beccari PB 3809; Haviland 1981* (type).

Ecology: *Fl.* April, Dec.

Notes. This apparently rare species is possibly allied to *C. vrieseanum* as well as to *C. pilosum.*

C. decipiens H. J. Lam (1932a, 209) is probably conspecific (see under doubtful species).

54. **Canarium hirsutum** Willdenow, 1805, 760; Engler, 1883, 150; Merrill, 1917, 302; Heyne, 1927, 877; Lam, 1932a, t. 13 f. 104c, t. 15 f. 117d, t. 16 f. 127d3 and f. 134; 1932b, 466, t. 11 f. 67; Burkill, 1935, 430; Lam, 1948, 7; Leenhouts, 1955a, 14, f. 7; 1956, 287. — *C. odoriferum*

hirsutum Rumphius, 1741, 157, t. 51. — *C. hispidum* Blume, 1823, 109; 1826, 1163, *incl.* also *var. scabrum*; Roemer & Schultes, 1829—30, 81, 1624; Hasskarl, 1844, 617, *incl. var. majus*; Engler, 1883, 131, *incl.* also *var. tomentellum*; Koorders & Valeton, 1896, 43; Koorders, 1898, 375; Solereder, 1899, 217, f. 43F; Hochreutiner, 1905, 86, *incl. f. minor*; Guillaumin, 1909a, 238, f. 22⁴; Backer, 1911, 198; Koorders, 1912, 433; Blaauw, 1917, t. 6; Ridley, 1922, 374; Henderson, 1930, 91. — *Boswellia hirsuta* Sprengel, 1825, 313, *non* Smith, 1819. — *C. altissimum* Blume, 1826, 1163; Engler, 1883, 130; Merrill, 1923, 355. — *Pimela hirsuta* Blume, 1850, 223. — *Pimela hispida* Blume, 1850, 224, *incl.* also *var. axillaris, imbricata* and *scabra.* — *Pimela altissima* Blume, 1850, 225. — *C. multipinnatum* Llanos, 1851, 107; Blanco, 1879, 87; Fernandez-Villar, 1880, 40; Merrill, 1918a, 207; 1923, 351; Beans & *al.*, 1932, 299—302, t. 2 f. 2. — *Canariopsis altissima* Blume *ex* Miquel, 1859, 651. — *Canariopsis hispida* Blume *ex* Miquel, 1859, 652, *incl.* also *var. tomentella.* — *Canariopsis hirsuta* Blume *ex* Miquel, 1859, 653. — *C. riedelianum* Engler, 1883, 130. — *C. greshoffii* Koorders, 1898, 375; 1903, 95; 1922a, t. 26; 1922b, 14. — *C. emarginatum* Engler *ex* Koorders, 1903, 97, *nom. nud.*; 1922a, t. 25; 1922b, 13. — *C. bersamifolium* Perkins, 1904, 90. — *C. radlkoferi* Perkins, 1904, 96. — *C. warburgianum* Perkins, 1904, 99; Merrill, 1923, 355. — *C. ahernianum* Merrill, 1906b, 70; Whitford, 1906, 415; Merrill, 1923, 415. — *C. racemosum* Merrill, 1908b, 141; Elmer, 1911, 1077; Merrill, 1923, 353. — *C. nervosum* Elmer, 1908, 482; 1915, 2566; Merrill, 1923, 352. — *C. costulatum* Elmer, 1911, 1080; Merrill, 1923, 349. — *C. ellipsoideum* Merrill, 1915a, 26; 1923, 350. — *C. robustum* Merrill, 1916a, 184; 1923, 353. — *C. subcordatum* Ridley, 1920, 175; 1922, 374. — *C. palawense* Lauterbach, 1921, 515; Kanehira, 1931, 288; 1933, 160, f. 59; 1935, 344. — *C. longiflorescens* Elmer (*ex* Merrill, 1923, 352, *in syn.*), 1939, 3713, *descr. angl.* — *C. oxygonum* Quisumbing & Merrill, 1928, 155. — *C. bataanense* Merrill *ex* Sasaki, 1930, 295, *nom. nud.* — *C. multijugum* Lam, 1932a, 212, t. 5 f. 5; 1932b, 476, t. 11 f. 7. — *Fig. 30.*

Type: Moluccas, Morotai, Totodoku, alt. 30 m, May 6, 1949, *FRI. bb. 33772 (Tangkilisan 77)*, fr., neotype (L; isotypes in A, BO, SING).

Tree *c.* 10—25(—48) m by 20—60(—200) cm. *Branchlets* very stout, 1½—3 cm thick, the tip ferruginously pubescent; pith large, with many small vascular strands, which are all or nearly all appressed to the wood-cylinder (rarely all scattered). *Stipules* nearly always present, rather caducous, inserted on the petiole ½—5 cm from its base, subulate, 4—12 mm, pubescent. *Petiole* thick (up to 2 cm at the base) with sharp edges. *Leaves* 4—13-jugate, up to 2 m long, pubescence variable. *Leaflets* subsessile except the basal ones, mostly ovate to rather narrowly lanceolate, 5—45 by 2½—15 cm, chartaceous, sparsely pilose to glabrous; base rounded to cordate; margin entire; apex gradually to rather abruptly short-acuminate; nerves 12—30 pairs (angle 60—90°), straight to slightly curved, usually not arching but for the apical ones. *Inflorescences* axillary, laxly thyrsoid (♂) to subracemose (♀), ♂ up to 70 cm long, ♀ up to 30 cm, ♂ flowers usually crowded in many-flowered glomerules, ♀ ones single or in few-flowered cymules; usually densely tomentose. *Flowers* 1—1¼ cm long, short-stalked. *Calyx* shallowly cupular, subtruncate, 1½—3½ mm high. *Corolla* much exserted, densely appressedly fulvous-tomentose without. *Stamens* free, filaments slender, pilose, in ♂ flowers *c.* 1 cm, twisted, in ♀ flowers *c.* ½ cm. *Disk* in ♀ flowers 6-lobed, 1 mm high, pilose, in ♂ flowers cupular, *c.* 2 mm high, densely erect-pilose. *Pistil* sometimes stalked, densely pilose; in ♂ flowers (nearly) absent. *Infructescences* recurved to pendulous, racemose, up to *c.* 15 cm long and with few fruits, to thyrsoid, more than 30 cm long and with many fruits; calyx 4—16 mm diam., flat, lobes often recurved. *Fruits* nearly always with long-remaining, irritating, stiff, reddish-brown hairs, ovoid, 2—6¼ by 1¾—4½ cm, otherwise rather variable (see varieties).

Distribution: Throughout Malaysia (not yet known from the Lesser Sunda Islands), Carolines (Palau), and Solomon Islands.

Taxonomy. This species is very variable, especially in its fruits. As these differences in the fruits are correlated with some vegetative characters, and as all these variations are more or less geographically restricted, I propose the following subdivision of the species:

KEY TO THE VARIETIES

1.a. Pyrenes with some straight ribs only (at most 3 at every angle and a median one on every lid); fruits very variable, mostly densely setose. Leaves 4—12-jugate; leaflets usually relatively broad, especially near the base. Inflorescences narrowly thyrsoid
subsp. **hirsutum** 2
b. Pyrenes deeply irregularly furrowed all over the surface; fruits short and broad, sparsely setose to nearly glabrous. Leaves 6—10-jugate; leaflets relatively narrow, sparsely tomentose to glabrous. Inflorescences rather broadly thyrsoid
subsp. **multicostulatum** 3
2.a. Stipules present . . . . var. **hirsutum**
b. Stipules absent . . . . var. **beccarii**
3.a. Stipules absent . . . . var. **multicostulatum**
b. Stipules present . . . . var. **leeuwenii**

A. Subsp. **hirsutum**. — Nearly all synonyms, except two (see under subsp. *multicostulatum*).

Leaves 4—12-jugate. Leaflets relatively broad, specially near the base. Inflorescences narrowly thyrsoid. Fruits very variable, mostly densely pilose. Pyrene with some straight ribs, at most 3 at every angle and a median one on every lid.

a. var. **hirsutum**. — Synonyms as the subsp.

Stipules present. Pyrene with 3—12 straight ribs; fruit long remaining pilose. Seeds 1—2, sterile cells more or less reduced.

Distribution: Carolines (Palau Isl.) and throughout Malaysia, except New Guinea and New Britain.

Notes. In this very polymorphous and wide-spread variety some geographical forms are distinguishable, which are mainly characterized by their fruit structure.

1. forma **scabrum** (Bl.) Leenhouts, 1955a, 16. — *C. hispidum var. scabrum* Bl. — *Fig. 30b.*

Type: Java, Salak, *Blume in herb. L 898.319—289,* ♂ (L; isotypes in U, W).

This form is characterized by its small, strongly pilose fruits, its pyrene with acute angle-ribs, flat sides with a median rib, and mostly with 2 sterile cells. It is the most common, western form and found eastward as far as Palau Isl., Philippines, and Borneo.

Note: One of the more remarkable local races, belonging to this form, described as *C. multipinnatum* Llanos, is restricted to the Philippines and is characterized by its 10—12-jugate leaves, its small (9—11 by 4½—5 cm), broadly elliptic, abruptly and shortly broad-acuminate leaflets (like those of *C. euryphyllum*) and its small flowers.

2. forma **ahernianum** (Merr.) H. J. Lam, 1932a, 212; 1932b, 468. — *C. ahernianum* Merr. — *Fig. 30c.*

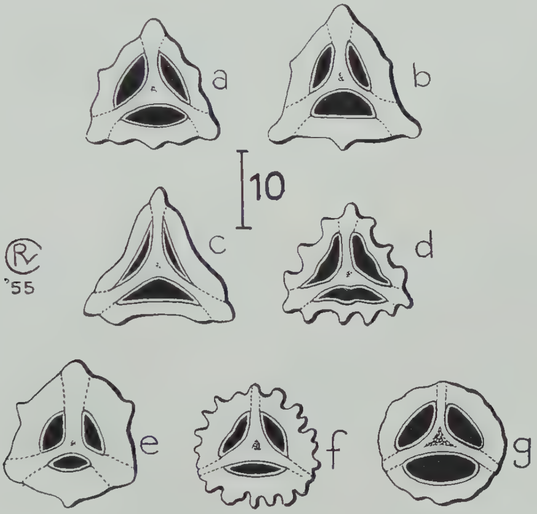

Fig. 30. *C. hirsutum*, cross-sections of fruit-kernels — a. *f. hirsutum* (*Kostermans 143*); b. *f. scabrum* (*Koorders 27312*); c. *f. ahernianum* (*BS. 22833*); d. *f. racemosum* (*PNH 9897*); e. *var. beccarii* (*Beccari herb. 2171*); f. *var. multicostulatum* (*Beguin 2245*); g. *var. leeuwenii* (*Kajewski 1931*) (dimensions in mm).

Type: Philippines, Luzon, Rizal Prov., Antipolo, Febr. 1904, *FB. 422 (Ahern's coll.)*, fr., lectotype (PNH; isotypes in BM, K, NY, SING).

Pyrene with blunt angle-ribs, hollow sides without a median rib, and mostly with 2 sterile cells; fruit rather broad, very hairy; leaflets densely pilose, nerves only slightly prominent.

Apparently restricted to Luzon.

3. forma **racemosum** (Merr.) H. J. Lam, 1932a, 212; 1932b, 469. — *C. racemosum* Merr. — *Fig. 30d.*

Type: Philippines, Mindanao, Davao Distr., Mt Apo, Todaya, alt. 1100 m, May 1909, *Elmer 10763*, fr., neotype (L; isotypes in A, BM, BRSL, E, FI, G, K, NY, P, U, W, Z).

Pyrene with blunt angle-ribs, lids with a median rib and well-developed, acute marginal ribs, 1 sterile cell; leaflets very pilose, nerves sunken above, prominent beneath.

Known from Samar, Leyte, and Mindanao.

4. forma **hirsutum.** — *Fig. 30a.*

This form is characterized by a thick-walled pyrene with blunt angle-ribs, lids with median rib and slightly thickened margins, and mostly 2 sterile cells.

Known from S.W. Celebes (Bonthain) and the Moluccas (Morotai, Halmaheira, and Ternate).

b. var. **beccarii** Leenhouts, 1955b, 189; 1956, 289. — *Fig. 30e.*

Type: S.E. Celebes, Lepo-Lepo near Kandari, July 1874, *Beccari herb. 2171,* fr. (FI; isotype in L).

Pith of the branchlet with many, scattered, small, vascular strands. Stipules absent. Leaflets sparsely, patently stiff-pilose on the nerves beneath; nerves 14—16 pairs. Fruit ellipsoid, round in cross-section, acute at apex, 2¾—3 by 1¾—2 cm; pyrene rostrate, gibbous, angle-ribs acute, lids with acute median rib; 2 sterile cells.

Distribution: S.E. Celebes.

Note. The taxonomic position and status of this variety remains doubtful.

B. Subsp. **multicostulatum** Leenhouts, 1955b, 191, f. 5e; 1956, 289. — *C. hirsutum* Willd. *f. ϑ leeuwenii* and *f. ζ multicostulatum* H. J. Lam. — *C. multijugum* H. J. Lam.

Type: Moluccas, Halmaheira, W. Pitu, alt. 60 m, Nov. 11, 1922, *Beguin 2245,* fr. (L; isotype in BO).

Leaves 6—10-jugate. Leaflets relatively narrow, sparsely tomentose to glabrous. Inflorescences rather broadly paniculate. Fruits short and broad, sparsely pilose to nearly glabrous; pyrene deeply irregularly furrowed all over the surface.

c. var. **multicostulatum.** — *C. hirsutum* Willd. *f. ζ multicostulatum* H. J. Lam. — *C. multijugum* H. J. Lam. — *Fig. 30f.*

Stipules absent. Leaves 9—10-jugate. Nerves 20—25(—30) pairs. Leaflets glabrous. Fruits broadly ovate, terete, 2 by 1½—1¾ cm, nearly glabrous; pyrene deeply and irregularly furrowed.

Distribution: Moluccas (Halmaheira).

d. var. **leeuwenii** Leenhouts, 1955b, 191; 1956, 289. — *C. hirsutum* Willd. *f. ϑ leeuwenii* H. J. Lam. — *Fig. 30g.*

Type: Solomon Islands, Bougainville, Kugumaru, Buin, alt. 150 m, July 5, 1930, *Kajewski 1931,* fr. (L; isotypes in A, BISH, BO, BRI, G, P, SING).

Pith of the branchlets very fibrous. Stipules present. Leaves 6-jugate. Leaflets glabrescent; nerves 14—15 pairs. Fruits nearly globose, 3½ by 2¾ by 2¾ cm, nearly glabrous, with very thick (4 mm), fibrous pericarp; pyrene irregularly shallowly furrowed (peach-like), 2 cells sterile.

Distribution: Solomon Islands, New Britain, and New Guinea.

SUMATRA. *Beccari PS 495 (sp. dub.* aff. 1); *Teysmann HB 601* (type *Canariopsis hispida var. tomentella* Miq.) (1), *HB 706* (1).

Malay Peninsula. *Burkill 906* (type *C. subcordatum* Ridl.) (1); *SF. 18242 (Henderson)* (1).

Java. *Backer 18576* (1), *27870* (1), *27922* (1); *Blume 1365* (type *C. altissimum* Bl.) (1), *in herb. L 898.319—214* (1), *in herb. L 898.319—278, 280* (syntype *Pimela hispida var. axillaris* Bl.) (1), *in herb. L 898.319—279* (syutype *Pimela hispida var. axillaris* Bl.) (1), *in herb. L 898.319—287, 289* (type *C. hispidum var. scabrum* Bl) (1), *in herb. L 901.65—289* (syntype *C. hispidum* Bl.?) (1), *in herb. L Carp. 890a* (1); *Brinkman 823* (1); *Burck in herb. L Carp. 1450* (1?); *Buwalda 3137* (1); *Horsfield 214* (1), *in herb. U 032897* (1); *Koorders (all β numbers) 916* (1), *918* (1), *919* (1), *920* (1), *921* (*sp. dub.* 1), *922* (1), *923* (1), *924* (1), *925* (1), *943* (1), *944* (1), *945* (1), *946* (1), *947* (1), *948* (1), *949* (1), *950* (1), *951* (1), *952* (1), *953* (1), *954* (1), *955* (1), *956* (1), *957* (1), *958* (1), *959* (1), *960* (1), *961* (1), *963* (1), *964* (1), *965* (1), *966* (1), *978* (1), *982* (1), *997* (1), *7566* (1), *12521* (1), *12525* (1), *12773* (1), *13161* (1), *15675* (1), *20258* (1), *22706* (1), *23782* (1), *24644* (1), *25080* (1), *25126* (1), *25324* (1), *26089* (1), *26127* (1), *26860* (1), *27237* (1), *27312* (1), *27314* (1), *28881* (1), *28883* (1); *Korthals 138* (1), *in herb. L 898.319—288* (1), *in herb. L 908.339—763* (1), *in herb. L 898.319—213, 925. 250—620* (1); *Kostermans 6220* (1); *Kostermans & Van Woerden 173* (1); *Noltée 4605* (1); *Reinwardt in herb. L 898.319—286, 909.54—181, 182* (1); *De Voogd 663* (1); *herb. L 898.319—132* (type *C. hispidum var. majus* Hassk.) (1).

Borneo. *Clemens 9898* (1), *10035* (1), *26991* (1), *27391* (1); *Endert 2175* (1); *FRI. bb. 10152* (1), *bb. 18959 (v. d. Zwaan 984)* (1); *Korthals in herb. L 898.319—281, 282, 284* (type *Pimela hispida var. imbricata* Bl.) (1); *Kostermans 4662* (1), *4679* (1), *6959* (1); *Mondi 132* (1); *NBFD SH 10290 (Enchai)* (1); *SF. 20128 (Henderson)* (1), *20231 (Henderson)* (1); *Van Steenis 737* (1), *981* (1).

Philippines. Palawan: *BS. 45932 (MacGregor)* (1), *77723 (Edaño)* (1); *Elmer 12941* (1); *FB. 3803 (Curran)* (1), *23355 (Natividad)* (1), *29236 (Cenabre)* (1); *Merrill 9199* (1), *9314* (1); *Vidal 2293* (1). — Busuanga: *Marche 357* (1). — Mindoro: *FB. 3627 (Merritt)* (1), *3728 (Merritt)* (1); *Merrill 2230* (syntype *C. radlkoferi* Perk.) (1); *PNH. 19027 (Conklin 569)* (4—1); *Whitford 1445* (1). — Luzon: *Ahern 789* (1); *BS. 19182 (Reillo)* (1), *21968 (Ramos)* (type *C. ellipsoideum* Merr.) (aff. 1?), *22833 (MacGregor)* (2), *28197 (Fénix)* (1), *45723 (Ramos & Edaño)* (type *C. oxygonum* Quis. et Merr.) (1), *76865 (Ramos)* (1); *Elmer 15527* (2), *17093* (2); *FB. 123 (Barnes)* (syntype *C. ahernianum Merr.*) (aff. 2), *329 (Barnes)* (1), *422 (Ahern's coll.)* (lectotype *C. ahernianum* Merr.) (2), *2558 (Borden)* (1), *17592 (Curran)* (1), *17899 (Barros)* (1), *24289 (Bawan & Borromeo)* (3?), *25826 (Paraiso)* (1), *30828 (Oro)* (a); *Loher 274* (1), *5862* (1); *Merrill 1985* (a), *2349* (paratype *C. bersamifolium* Perk.) (1), *2607* (1), *Species Blancoanae 608* (1), *Species Blancoanae 909* (1); *Ramos 1930* (2); *Vidal 703* (1), *1024* (1), *1344* (1), *2283* (1); *Whitford 1254* (syntype *C. ahernianum* Merr.) (2); *Williams 363* (2). — Catanduanes: *BS. 75782 (Ramos & Edaño)* (1.) — Samar: *BS. 24450 (Ramos)* (paratype *C. robustum* Merr.) (3); *FB. 12833 (Rosenbluth)* (3); *PNH. 6080 (Sulit)* (1), *14485 (Sulit 4325)* (1). — Leyte: *Elmer 7242* (type *C. nervosum* Elm.) (1); *Wenzel 761* (1), *1555* (1). — Negros: *Elmer 10341* (paratype *C. nervosum* Elm.) (1); *FB. 20685 (Tamesis)* (1). — Panay: *Vidal 2298* (1). — Basilan: *FB. 20081 (Miranda)* (1); *Hallier 4524* (aff. 1). — Mindanao: *Ahern 697* (1); *BS. 15699 (Fénix)* (1—2), *49216 (Ramos & Edaño)* (1), *83686 (Ramos & Convocar)* (1); *Elmer 10763* (neotype *C. racemosum* Merr.) (3), *10817* (1), *11069* (1), *11215* (type *C. costulatum* Elm.) (3), *12015* (1); *FB. 31279 (Ponce)* (1); *PNH. 9897 (Sulit 3151)* (3); *Zwickey 601* (3).

Celebes. *Beccari herb. 2169 A* (paratype *C. hirsutum var. beccarii* Leenh.) (b), *herb. 2170* (paratype *C. hirsutum var. beccarii* Leenh.) (b), *herb. 2171* (type *C. hirsutum var. beccarii* Leenh. (b), *herb. 2172* (paratype *C. hirsutum var. beccarii* Leenh.) (b); *FRI. bb. 5431* (4), *bb. 17289 (Tumbel 3)* (a—b?), *bb. 19603 (Verhoef 118)* (4), *bb. 21389 (Waturandang 144)* (?), *Cel./I-1* (4), *Cel./I-94* (?), *Cel./III-54* (aff. b?), *Cel./-316 (Waturandang 538)* (aff. 4), *Cel./V-382* (?); *Koorders (all β numbers) 16293* (aff. 4), *16295* (aff. 4), *16301* (4?), *16306* (type *C. greshoffii* Kds.) (?), *16309* (?); *Posthumus 2344* (*sp. dub.?* aff. b); *Riedel s.n.* (type *C. riedelianum* Engl.) (a); *Teysmann 14170* (4—1?).

Moluccas. Morotai: *FRI. bb. 33772 (Tangkilisan 77)* (neotype *C. hirsutum* Willd.) (4), *bb. 33832 (Tangkilisan 143)* (4); *Lam 3652 (sp. dub.)*; *Main & Aden 626* (4), *932* (4). — Halmaheira: *Beguin 1758* (4), *2106* (type *C. multijugum* H. J. Lam; paratype *C. hirsutum ssp. multicostulatum* Leenh.) (c), *2245* (type *C. hirsutum ssp.*

multicostulatum Leenh.) (c). — Ternate: *Beguin 6* (4), *1409* (4); *FRI. bb. 24539 (de Haan 351)* (aff. 4). — Sula Islands: *FRI. bb. 28832* (?), *bb. 29821* (aff. 4). — Ceram: *FRI. bb. 25882 (Buwalda 537)* (a—b?).

NEW GUINEA. *Brass 3869* (d?); *Docters van Leeuwen 11275* (paratype *C. hirsutum var. leeuwenii* Leenh.) (d); *FRI. bb. 30280* (c?).

CAROLINES. Palau Islands: *Kanehira 549* (1), *2317* (1); *Kanehira & Hatusima 4945* (1); *Ledermann 14330* (type *C. palawense* Laut.) (1); *Takamatsu 1526* (1).

SOLOMON ISLANDS. Bougainville: *Kajewski 1931* (type *C. hirsutum var. leeuwenii* Leenh.) (d).

Ecology: Rather common in primary, rarely in secondary forests, in wet to dry localities, mostly at low altitudes (rarely up to 1800 m). *Fl. fr.* throughout the year, *fl.* specially Febr.—July, *fr.* specially April—Sept.

Wood anat.: Moll & Janssonius. Mikr. Holzes 2 (1908) 102 (*C. hispidum* Bl.).

Uses. Wood moderately hard to rather soft. "According to the natives of Bukidnon decoction of roots is good for stomach trouble" (Sulit). Resin rather abundant and probably of some importance (see Buckley, Mal. For. Rec. *no.* 11, 1932, 29).

Notes. *C. hirsutum* is a variable and wide-spread species, which, like *C. pilosum,* forms the centre of a group of related, more constant species, each differing in a few characters and each with a rather limited area. In contradistinction to *C. pilosum,* however, *C. hirsutum* is apparently also geographically the centre of this group of species, as is demonstrated very well by the map fig. 12.

The mutual relationship of the infraspecific taxa of *C. hirsutum* is not quite clear. The subdivision is based mainly on fruit characters, but these prove to be correlated with characters of the leaflets (hairiness, more or less prominent nervation, colour of the dried leaves), an efficient description of which is often difficult. In contradistinction to most species of *Canarium,* this and some related species posses strong ribs on the fruit kernels. I believe the form with the slightest development of these ribs the most primitive one. This is forma *hirsutum* from the Moluccas (this distribution is interesting, since *C. balsamiferum,* which in my opinion is a more primitive species, closely related to *C. hirsutum,* is known from Celebes and the Moluccas).

From this basal form, development has apparently taken two directions, morphologically as well as geographically. Subsp. *multicostulatum* represents the eastern direction towards New Guinea: the ribs on the fruit kernels are many and they are strongly, though irregularly developed; in contradistinction to subsp. *hirsutum* the fruits are rather soon glabrescent; moreover, in var. *multicostulatum* the stipules are absent. (This subspecies forms the connection with the related Papuan species *C. polyphyllum, rigidum,* and *cestracion,* all of which posses strongly furrowed fruit kernels, glabrous fruits, and no stipules.) I did not come across any specimen intermediate between subsp. *multicostulatum* and subsp. *hirsutum,* and apparently these two trends represent the primary segregation within the species.

Subsp. *hirsutum* — especially var. *hirsutum* — represents the western direction of development. Like in some other species — *e.g. C. asperum* and *euryphyllum* — in the Philippines the variability, especially in some characters of minor taxonomical importance, is fairly large. Here two rather well distinguishable races have been evolved, *viz.* formae *ahernianum* and *racemosum,* both showing an extreme development of the ribs on the pyrene. Forma *scabrum* is close to forma *hirsutum* — there are some intermediate specimens — and it occurs throughout the Philippines and the western half of the Malaysian Archipelago. It is rather variable, and some local populations are more or less distinguishable, but constant, well definable forms have apparently not (yet) developed.

I am still not quite certain about the status of var. *beccarii.* On the one side it is a well defined local population, quite distinct from the other forms by the absence of stipules and by the rather hairy lower side of the leaflets; on the other side, it is doubtless very close to *C. hirsutum,* especially in its flowers and fruits, and some specimens from N. Celebes and Ceram seem to be intermediate between f. *hirsutum* and var. *beccarii.* Up to now the flora of Celebes is still too insufficiently known for solving puzzles like this one.

The species as a whole is usually easily recognizable: the habit is very coarse, the twigs are stout with a thick and soft pith, the petioles are heavy and sharp-edged, the leaflets stiff and scabrous, the flowers rather large, conical in bud, and pilose, the fruits usually densely prickly hairy.

55. Canarium pseudosumatranum Leenhouts, 1955b, 193, f. 4; 1956, 286. — *C. sumatranum* (*non* Boerl. & Koord.) H. J. Lam, 1932b, 474, *pro min. parte* (*incl.* t. 11 f. 69b); Wyatt-Smith, 1953, 7, *cum fig.*

Type: Malay Peninsula, Selangor, Kuala Lumpur Distr., Bukit Langong for. res., May 9, 1951, *KEP. 55781 (Sow Lindong),* ♂ (KEP; isotype in K).

Tree, up to *c.* 50 m by 120 cm, with short thick buttresses. *Branchlets* stout, *c.* 12 mm thick, glabrous but for the tomentose terminal bud; pith with a peripheral cylinder of small vascular strands closely appressed to the wood. *Stipules* absent (see Notes). *Leaves* 7—9-jugate, glabrous. *Leaflets* narrowly lanceolate, 13—20 by 3½—5 cm, stiff-chartaceous; base slightly oblique, rounded to subcordate, often slightly decurrent; margin entire; apex gradually, long (*c.* 1 cm) and slender blunt-acuminate; nerves 16—20 pairs (angle *c.* 55°), straight to slightly curving, close to the margin strongly curving and indistinctly arching. *Inflorescences* (♀ unknown) axillary, narrowly thyrsoid, *c.* 20 cm long, glabrous, partial panicles nearly decussate, patent, up to 2 cm long, shortly stalked, laxly cymose, many-flowered; *bracts* small, triangular. *Flowers* (♀ unknown) 1 mm pedicelled, 7 mm long, slender. *Calyx* 2 mm high, (sub)glabrous. *Petals* outside towards the top slightly rugose. *Stamens* glabrous, unequally high confluent at the base (*c.* 2—4 mm). *Disk* tubular, 1 mm high, thick-fleshy, on the rim and the inner side densely pilose; no pistil. *Infructescences* unknown. *Fruits* ovoid, round in cross-section, 5 by 2½ cm, glabrous; pericarp rather thick; pyrene with blunt angle-ribs, lids very distinct, each with an acute median rib; lids 2½ mm thick. *Seeds* 2, sterile cell slightly smaller.

Distribution: Assam (?) and the Malay Peninsula.

Malay Peninsula. *KEP. 2132 (Bonar)* (paratype), *11599 (Hamid)* (paratype), *20476 (Strugnell)* (paratype), *20900 (Bain)* (paratype), *23087 (Symington)* (paratype), *55781 (Sow Lindong)* (type), *71256 (Wyatt-Smith)* (paratype), *71974 (Sow Lindong)* (paratype).

Ecology: Lowland and hill forests, *fl.* March—May, *fr.* Dec.

Notes. Possibly, one inadequate specimen from Assam — *Upendranath Kanjilal 4966,* fr., Darrang Distr. — belongs also to the present species. It is distinctly smaller in its vegetative parts and its fruits, however, and there are stipule-scars at the base of the petiole. It might represent a separate subspecies or even a related species; more complete material is desirable.

The species is related to *C. sumatranum,* differing, however, by the absence of stipules, by the narrower, stiff, gradually acuminate leaflets, the narrow inflorescences, and especially by the much larger, quite different fruits.

56. **Canarium sumatranum** Boerlage & Koorders *in* Koorders-Schumacher, 1910, 25; Guillaumin, 1912, 211, t. 16; Lam, 1931—32a, t. 5 f. 3, t. 11 f. 78, t. 16 f. 132; 1932b, 474, t. 11 f. 69, *excl. fr.*; Leenhouts, 1956, 286. — *Fig. 31.*

Type: Sumatra, Bengkulu, Mokko-Mokko, alt. 100 m, Febr. 19, 1891, *Koorders 10282 β*, st. (BO).

Tree up to 50 m by 120 cm, with up to 1½ m high buttresses; in young specimens the stem and branches thorny. *Branchlets* stout, 1½—2 cm thick, glabrous except the densely reddish-brown tomentose terminal bud which is *c.* 3½ cm long, acute and often curved, pith thick with numerous, scattered, small vascular strands, most of them crowded towards the periphery. *Stipules* nearly always absent, if present early caducous, inserted at the base of the petiole, subulate, *c.* 3 mm. *Leaves* 7—11-jugate, often without a terminal leaflet. *Leaflets* oblong, *c.* 20 by 5—8 cm, herbaceous (to subchartaceous), glabrous; base very broad, subcordate to broadly cuneate; margin entire; apex rounded, abruptly shortly and blunt-acuminate, or gradually long (—2½ cm) acute-acuminate; nerves 20—26 pairs (angle 80—90°), s-shaped to faintly curving, close to the margin abruptly strongly curving upwards and more or less distinctly arching. *Inflorescences* (♀ unknown) axillary, broadly and laxly thyrsoid, up to 45 cm long, many-flowered, slightly puberulous towards the tips or glabrous, main branches up to 17 cm, narrowly thyrsoid on a long stalk; *bracts* minute, squamate. *Flowers* (♀ unknown) subsessile, 8—9 mm long, glabrous outside. *Calyx* 3 mm high. *Petals* towards the top much incrassate with rugose lateral surfaces. *Stamens* glabrous, 7 mm long, connate for (2—)4—5 mm. *Disk* about globular, with 6 thick lobes and a central canal, 1 mm high, minutely pubescent, without pistil. *Infructescences* laxly thyrsoid, 20—30 cm long, with *c.* 15—20 fruits, glabrous; calyx saucer-shaped, triangular, 7 mm diam.; remains of the disk faintly 6-lobed, about 1 mm high, fimbriate. *Fruits* ovoid, rounded 3-angular in cross-section, 1½ by 1 cm, glabrous; pyrene nearly smooth; lids 1 mm thick. *Seeds* 2, sterile cell slightly smaller.

Distribution: Sumatra, Malay Peninsula.

SUMATRA. *Achmad 1416; FRI. bb. 5989; Koorders 10282 β* (type); *Lörzing 5677, 5677a.*

MALAY PENINSULA. *KEP. 4452 (Borges); Wray Jr. 3493.*

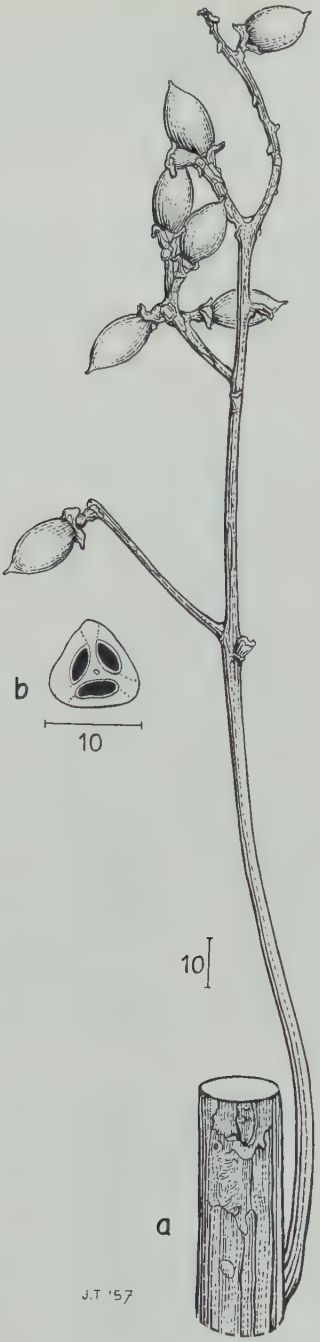

Fig. 31. *C. sumatranum* — a. infructescence; b. fruit-kernel in cross-section (*Wray jr. 3493*) (dimensions in mm).

Ecology: In primary and secondary forests, up to 500 m, *fl.* May, Oct., Nov. (Sum.), *fr.* Oct. (Mal. Pen.).

Wood anat.: Webber, Lilloa 6 (1941) 450, t. 3 f. 7.

Notes. In the Malay Peninsula the closely related *C. pseudosumatranum* is much commoner than the present species. The two species were usually confused, though they differ in many points (see under the preceding species).

57. Canarium rigidum (Bl.) Zippelius *ex* Miquel, 1859, 648; Engler, 1883, 142, t. 3 f. 3—5; 1896, f. 136 V—W; 1931, f. 211 V—W; Lam, 1932a, t. 12 f. 85; 1932b, 478, t. 11 f. 71, *excl. syn. Pimela (Canariopsis, Canarium) angustifolia* Bl.; Leenhouts, 1956, 290. — *Pimela rigida* Blume, 1850, 222. — *Fig. 32.*

Type: New Guinea, *Zippel 189,* ♂ (L; isotypes in BRSL, U).

Slender tree up to 25 m. *Branchlets* rather stout, 7—12 mm thick, glabrous but for the tips; pith with a peripheral closed cylinder of small vascular strands. *Stipules* absent. *Leaves* 6—12-jugate, glabrous. *Lateral petiolules* 2—11 mm. *Leaflets* lanceolate, 6¼—15 by 1¼—4 cm, chartaceous; base rounded to subcordate; margin entire; apex gradually, long and slender-acuminate; nerves 15—20 pairs (angle 70—85°), irregular, not to faintly curved, abruptly arching at *c.* 1—2 mm from the margin; intermediate veins strongly developed. *Inflorescences* (♀ unknown) axillary, laxly thyrsoid, 10—20 cm long, glabrous, peduncle globular-thickened at the base; main branches subdecussate, up to 5 cm, dichotomously branched, crowded-9—12-flowered; *bracts* persistent, deltoid, 1 mm long. *Flowers* (♀ unknown) subsessile, glabrous, 6 mm long. *Calyx* 3 mm high. *Petals* much incrassate towards the apex, the broadened and flattened margins of the apical part rugose. *Stamens* glabrous, 4½—5 mm long, connate for 2 mm. *Disk* cushion-shaped with elevated margin, 1 mm high, minutely pubescent on the upper surface, with a central canal, but without a rudimentary pistil. *Infructescences* 12—25 cm long, with 1—3 fruits, glabrous; main branches up to 6 cm; calyx shallowly saucer-shaped with a 3-lobed margin; remains of a circular, fimbriate disk present. *Fruits* ellipsoid, tapering at the base, acuminate at the apex, rounded 6-angular in cross-section, 4 by 2—2½ cm, glabrous; pericarp rather thick and fleshy; pyrene circular in cross-section with many irregular, longitudinal ribs, which are up to 5 mm high and 1—2 mm wide; lids 2½ mm thick. *Seed* 1, sterile cells only slightly reduced.

Distribution: New Guinea.

NEW GUINEA. *Carr 15959; Clemens 8031; Zippel 189* (type).

Ecology: Primary and secondary forests, both at low altitude and up to 1000—1200 m, *fr.* March.

Note. Closely related to *C. polyphyllum,* and possibly even not specifically distinct. As, however, the material of both species is rather scanty, and as, up to now, it shows some real differences both in the fruits and in the leaves, I prefer for the time being to keep them apart.

58. Canarium polyphyllum K. Schumann *in* Schumann & Hollrung, 1889, 63; Lam, 1932a, t. 11 f. 77; 1932b, 479, t. 11 f. 72; Leenhouts, 1956, 290, f. 20d; *non* Kärnbach, 1893, 16, and Krause, 1913, 147, *cum fig.*

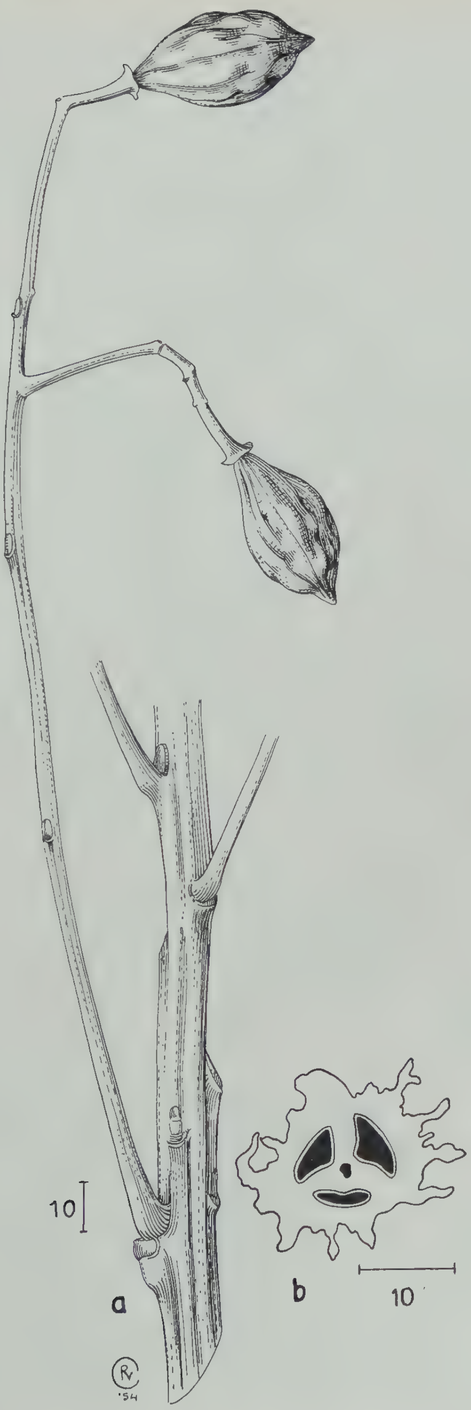

Fig. 32. *C. rigidum* — a. infructescence; b. fruit-kernel in cross-section (a. from *Carr 15959;* b. from *Clemens 8031*) (dimensions in mm).

(very probably these both refer to *C. indicum* L.). — *C. ledermannii* Lauterbach, 1920, 328, f. 2 A—E. — *Fig. 33.*

Type: N.E. New Guinea, Augusta River, 1887, *Hollrung s. n.*, ♂ (B; isotypes in BRSL, K, L, MEL, P, U).

Tree, up to 30 m high, with buttresses. *Branchlets* ¾—1½ cm thick, glabrous, the velvety young parts excepted; pith with many minute vascular strands, closely appressed to the wood-cylinder. *Stipules* absent. *Leaves* 3—11-jugate. *Leaflets* narrowly oblong, 5½—20 by 2½—8 cm, chartaceous, glabrous but for the minutely pubescent midrib above and midrib and main nerves beneath; base rounded (to subcordate); margin entire; apex rounded, rather abruptly, shortly and acute-acuminate; nerves 11—24 pairs (angle 60—70—90°), slightly irregular, strongly curving towards the margin, indistinctly arching remote from it; intermediate veins more or less well developed. *Inflorescences* (♀ unknown) axillary, laxly thyrsoid, 15—48 cm long, pubescent towards the tips; partial panicles up to 8 cm long, long-stalked, cymose, *c.* 15-flowered, flowers clustered; *bracts* persistent, deltoid, 1 mm long. *Flowers* (♀ unknown) subsessile, 6 mm long, glabrous. *Calyx* 2½—3 mm high. *Petals* thickened towards the apex, the inflexed apiculum much thickened and rugose. *Stamens* glabrous, *c.* 4½ mm long, connate for *c.* 1½ mm. *Disk* 1 mm high, cushion-shaped, faintly 6-lobed, deepened towards the centre, narrowed at base, long-pilose on the upper surface; no pistil. *Infructescences* racemose to thyrsoid, 10—25 cm long, with 5—7 fruits, glabrescent; main branches up to 5 cm long, with 1—2 fruits; calyx flat, faintly 3-lobed to circular, 8—10 mm diam., margin slightly undulate; remains of a 6-lobed, long-fimbriate disk present. *Fruits* ellipsoid, tapering at both ends, rounded 3-angular to circular in cross-section, 4—5 by 2—2½ cm, glabrous; angle-ribs of the pyrene acute, surface of the lids slightly undulate; lids *c.* 1 mm thick. *Seed* 1, sterile cells slightly reduced.

Distribution: New Guinea.

NEW GUINEA. *FRI. bb. 33504 (Kostermans 317); Hollrung in herb. L 898.319—342* (type); *Hoogland 5059; Ledermann 7504, 7941* (type *C. ledermannii* Laut.), *8277; NGF. 8764 (Womersley); Schlechter 16886.*

Ecology: In dense to open primary forests, up to *c.* 400 m, *fl.* June—Nov., *fr.* Sept.

Note. Closely related to *C. rigidum* (see there).

59. Canarium cestracion Leenhouts, 1955b, 189, f. 5g; 1956, 290, f. 21k.

Type: S.E. New Guinea, Central Prov., Koitaki, alt. 500 m, July 5, 1935, *Carr 12796,* fr. (SING; isotypes in BM, K, L).

Tree *c.* 20 m. *Branchlets* 8 mm thick, glabrous; pith fibrous by many, scattered small vascular strands. *Stipules* very caducous, inserted on the twig near the base of the petiole, leaving a minute scar. *Leaves* 3—5-jugate, glabrous. *Leaflets* ovate-lanceolate, 11—20 by 4½—7 cm, stiff-chartaceous; base rounded to broadly cuneate; margin entire; apex gradually narrowed into a short, broad and blunt acumen; nerves 10—12 pairs (angle 65—75°), straight to faintly curved, more strongly curved towards the margin, more or less distinctly arching at some distance from it. *Inflorescences* and *flowers* unknown. *Infructescences* axillary, racemose, 15—20 cm long, with 1—3 fruits, glabrous; calyx flat, 3-angular, 6—8 mm diam., lobes reflexed. *Fruits* ellipsoid, acuminate at base and apex, narrowly triangular in cross-section, 4—4½ by 2½—2¾ by *c.* 1½ cm, glabrous; pyrene deeply furrowed, angle-ribs very prominent, as are the median ribs of the lids; lids 3½ mm thick. *Seeds* 1—2; fertile cells long and narrow, sterile ones almost entirely reduced.

Distribution: E. New Guinea (Central Prov.).

NEW GUINEA. *Carr 12796* (type).

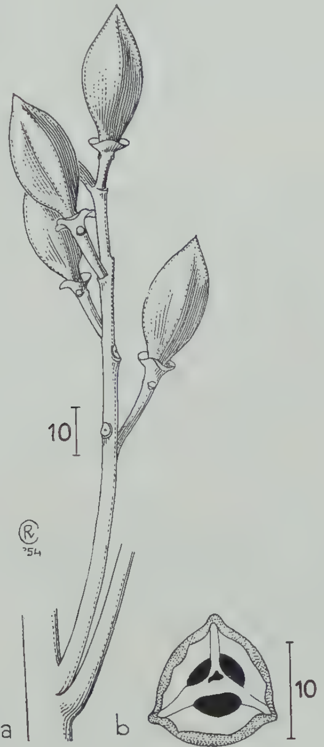

Fig. 33. *C. polyphyllum* — a. infructescence; b. fruit in cross-section (*Kostermans 317*) (dimensions in mm).

Ecology: In forests, 500 m. *Fr.* July.

Note. Apparently related to *C. rigidum* and *polyphyllum*; specially characterized by its very peculiar fruits.

60. Canarium vrieseanum Engler, 1883, 142, t. 3 f. 15—18; Koorders, 1922a, t. 30; 1922b, 17; Lam, 1932b, 455, t. 10 f. 63; Leenhouts, 1956, 291. — *C. williamsii* Robinson, 1908, 185; Brown, 1921, 302, f. 37; Merrill, 1923, 355. — *C. tongcalingii* Elmer, 1911, 1082; Merrill, 1923, 354. — *C. sibulanense* Elmer, 1911, 1085; Merrill, 1923, 353. — *C. dolichophyllum* Merrill, 1915a, 20; 1923, 350. — *C. villosiflorum* Elmer, 1915, 2569.

Type: Celebes, *De Vriese in herb. L 898.319—382,* ♀ & fr. (L).

Tree 15—25(—31) m by 30—45 cm, buttresses small or absent. *Branchlets* slender to rather stout, nearly always densely, minutely woolly ferruginous-pubescent, as are the leaves, inflorescences and sometimes the infructescences; pith with a peripheral cylinder of rather large vascular strands. *Stipules* inserted on the petiole up to 1½ cm from the base, often ribbon-shaped, tapering, and falcate, $^2/_5$—1 cm. *Leaves* 3—5(—7)-jugate. *Leaflets* ovate to oblong, 7—30 by 3—12 cm, chartaceous, more or less densely fulvous-pubescent on the midrib above and on all nerves beneath, rarely nearly glabrous; base slightly oblique, rounded to cuneate; margin entire; apex rather abruptly, up to 3 cm long, slender-acuminate; nerves rather prominent beneath, 12—18(—24) pairs (angle 55—75°), parallel, straight or slightly curved, more strongly curving towards the margin, gradually and vaguely arching close to it. *Inflorescences* axillary, narrowly thyrsoid (♂) to racemose (♀), 20—30(—60) cm long, 1—3(—5) cm wide, main branches patent, about 1½ cm long, 3—5-flowered (♀ ones 1—3-flowered), rarely some basal ramifications strongly developed. Buds fusiform, slender, fulvous-tomentose, closed. *Flowers* 6—10 mm long, nearly sessile. *Calyx* 6—8 mm high. *Stamens* glabrous, in ♂ flowers slightly and irregularly confluent at the base; in ♀ flowers free. *Disk* in ♀ flowers faintly 6-lobed, 1—2 mm high, fimbriate; in ♂ flowers ovoid, 1 mm high, pilose, with a central canal. *Pistil* densely pilose, ♂ none. *Infructescences* ascending to erect, 10—20(—45) cm long, with *c.* 5—10(—40) fruits; calyx flat, deeply 3-lobed (lobes not reflexed), ¾—1½ cm diam. *Fruits* ovoid, acute, round in cross-section, 1¾—3¼ by ¾—2¼ cm, remaining velvety for a long time; pyrene very faintly 6-ribbed, nearly smooth; lids *c.* 2½ mm thick. *Seed* 1.

Distribution: Philippines (Mindanao, according to H. J. Lam also in Luzon), Central and N. Celebes. A record from Buru, Moluccas, based on a cultivated tree in the Bogor Botanical Garden, is doubtful.

Taxonomy. Fairly polymorphous species, which can easily be subdivided into three local forms:

a. forma **vrieseanum**.

Slender form. Branchlets less than 1 cm thick. Leaves 3—5-jugate. Leaflets lanceolate, moderately hairy. Inflorescences narrowly thyrsoid, infructescences mostly racemose.

Distribution: Celebes.

b. forma **williamsii** (C. B. Rob.) Leenhouts, 1956, 291. — *C. williamsii* C. B. Rob.

Type: Philippines, Mindanao, Zamboanga Prov., Sax River, alt. 120 m, Febr. 7, 1905, *Williams 2111*, ♂ (PNH †; isotypes in K, NY).

Stout and hairy form. Leaves 6—7-jugate. Leaflets ovate, relatively large. Inflorescences and infructescences more widely thyrsoid, rather large, the latter with many fruits.

Distribution: Mindanao.

c. forma **stenophyllum** Leenhouts, 1955b, 194; 1956, 291.

Type: Philippines, Mindanao, Davao Prov., Mati, March—April 1927, *BS. 49156 (Ramos & Edaño)*, fr. (SING; isotype in NY).

Rather stout form. Leaves c. 7-jugate, nearly glabrous. Leaflets stiff, c. 20 by 4 cm; nerves 20—26 pairs, dense. Inflorescences small. Fruits rather small (c. 1¾ by 1¼ cm).

Distribution: Mindanao (Davao Prov.).

PHILIPPINES. Mindanao: *BS. 36680 (Ramos & Edaño)* (b), *49156 (Ramos & Edaño)* (type) (c), *49539 (Ramos & Edaño)* (paratype) (c); *Elmer 10996* (type *C. toncalingii* Elm.) (aff. c), *11206* (type *C. sibulanense* Elm.) (aff. b), *13347* (b), *13644* (type *C. villosiflorum* Elm.) (b); *FB. 20749 (Rafaël & Ponce)* (type *C. dolichophyllum* Merr.) (b), *28843 (Mallonga)* (b); *PNH. 13566 (Añonuevo 168)* (b), *13666 (Añonuevo)* (aff. c); *Williams 2111* (type *C. williamsii* C. B. Rob.) (b).

CELEBES. *Forsten in herb. U 78894* (a); *FRI. bb. 14151* (a), *bb. 14541* (a), *bb. 19414 (Uno 67)* (a); *Koorders (β numbers) 16302 (sp. dub.), 16313* (a), *16314* (a); *Riedel in herb. L 932.106—105* (aff. a); *Teysmann 5718* (a); *De Vriese in herb. L 898.319—382* (type) (a), *in herb. L 898.319—383* (a), *in herb. L 908.146—1893* (a), *in herb. L 908.146—1894* (a); *De Vriese & Teysmann in herb. L 908.146—1891/2* (a).
cultivated:
Hort. Bot. Bog. VI B 16 (a), *VI E 10* (a).

Ecology: In primary and secondary forests up to 500 m, *fl.* July—Dec.(—Febr.), *fr.* Dec.—Febr. (Celebes), March—June (Philipp., f. *stenophyllum*), July—Oct. (Philipp., f. *williamsii*).

Uses. The wood is said to be rather tough and hard, rarely more soft. The seeds are edible. Locally the resin is used for lighting purposes.

Notes. This species is related to *C. asperum,* particularly to its var. *clementis* from the Philippines.

C. vrieseanum is best distinguished by its rather narrow inflorescences, which are often nearly of the same width from base to apex, by the fusiform, brown tomentose flower-buds, and by the velvety pubescent, ovoid to ellipsoid fruits; moreover, the shape of the stipules is typical, they are nearly always stiff and slightly curved towards the branchlet.

61. Canarium asperum Bentham, 1843, 215; Engler, 1883, 135; Lam, 1932b, 461, t. 10 f. 66; Meijer Drees, 1951, 42; Leenhouts, 1955a, 10, f. 5; 1955b, 189; 1956, 293. — *Dammara nigra legitima* Rumphius, 1741, t. 53. — *C. commune* (*non* L.) Blanco, 1837, 791; Merrill, 1905a, 30; 1918a, 207. — *C. pimela* (*non* Koen.) Blanco, 1845, 545, t. 343; 1879, 200, t.; Merrill, *ll. cc.* — *Pimela legitima* Blume, 1850, 222. — *Pimela villosa* Blume, 1850, 223. — *Pimela denticulata* Blume, 1850, 226. — *C. legitimum* Miquel, 1859, 647; Engler, 1883, 127; Merrill, 1917, 300. — *Canariopsis villosa* Miquel, 1859, 652. — *Canariopsis aspera* Miquel, 1859, 653. — *Canariopsis denticulata* Blume *ex* Miquel, 1859, 654. — *C. villosum* Bentham & Hooker *f. ex* Fernandez-Villar, 1880, 40; Vidal, 1883, 19, t. 28 f. A; Brown, 1921, 49, f. 13; Merrill, 1923, 354; Yenko *et al.* 1934, 5, 9, t. 7 f. 3. — *C. molle* Engler, 1883, 109. — *C. minutiflorum* Engler, 1883, 123; Merrill, 1923, 351. — *C. zollingeri* Engler, 1883, 127; Koorders, 1912, 434; Heyne, 1927, 880. — *C. cumingii* Engler, 1883, 132; Elmer, 1911, 1077. — *C. luxurians* Engler, 1883, 146, *nom. illeg.* — *C. solo* Engler *ex* Koorders, 1903, 98, *nom. nud.;* 1922a, t. 29; 1922b, 16. — *C. treubianum* Engler *ex* Koorders, 1903, 98, *nom. nud.*; 1922a, t. 32; 1922b, 18. — *C. calophyllum* Perkins, 1904, 91; Merrill, 1923, 349; Lam, 1932a, t. 12 f. 83; 1932b, 529. — *C. juglandifolium* Perkins, 1904, 93; Merrill, 1906a, 28. — *C. lucidum* Perkins, 1904, 94; Merrill, 1923, 351; Lam, 1932a, t. 12 f. 82; 1932b, 530. — *C. poly-*

neurum Perkins, 1904, 96; Merrill, 1923, 353. — *C. stachyanthum* Perkins, 1904, 97; Merrill, 1906a, 29. — *C. thyrsoideum* Perkins, 1904, 98; Merrill, 1906a, 28. — *C. valetonianum* Engler (*ex* Koorders, 1903, 98, *nom. nud.*) *ex* Hochreutiner, 1904, 63; 1905, 86; 1910, 850; Koorders, 1922a, t. 33; 1922b, 18. — *C. koordersianum* Engler (*ex* Koorders, 1903, 97, *nom. nud.*) *ex* Hochreutiner, 1904, 63; Koorders, 1922a, t. 27; 1922b, 14. — *C. reticulatum* Merrill, 1908b, 141; 1923, 353; Lam, 1932b, 530, *non C. reticulatum* Ridley, 1930, 83, *quae est Dacryodes rostrata* H. J. Lam. — *C. clementis* Merrill, 1908b, 142; Elmer, 1911, 1078, *incl. var. perumbrinum.* — *C. leytense* Elmer, 1911, 1081. — *C. apoense* Elmer, 1911, 1083; Merrill, 1923, 349. — *C. ogat* Elmer, 1911, 1086; Merrill, 1923, 352; Lam, 1932b, 352. — *C. sibuyanense* Elmer, 1912, 1502. — *C. euphlebium* Merrill, 1913, 372; 1923, 350. — *C. wenzelii* Merrill, 1914b, 363; 1923, 355. — *C. heterophyllum* Merrill, 1915a, 19; 1923, 350. — *C. lagunense* Merrill, 1915a, 21; 1923, 350. — *C. barnesii* Merrill, 1915a, 22; 1923, 349. — *C. sanchezii* Merrill, 1915a, 27; 1923, 353. — *C. agusanense* Elmer, 1915, 2564; Merrill, 1923, 349. — *C. subvelutinum* Elmer, 1915, 2566. — *C. urdanetense* Elmer, 1915, 2568; Merrill, 1923, 354; Lam, 1932b, 531. — *C. samarense* Merrill, 1916a, 183; 1923, 353. — *C. tamborae* Lauterbach, 1920, 327. — *? C. fulvum* Lauterbach, 1920, 330; Lam, 1932a, t. 16 f. 127c^1; 1932b, 458, t. 10 f. 64. — *C. unifoliolatum* Merrill, 1921, 267; 1923, 354; Lam, 1932b, 533. — *C. papuanum* H. J. Lam, 1932a, 211, t. 12 f. 86, t. 13 f. 104k; 1932b, 459, t. 10 f. 65.

Type: New Guinea, *Hinds,* ♀ & fr., *n. v.*

Tree 8—35 m by 5—70(—more than 100) cm, rarely a shrub, very rarely buttressed. *Branchlets* rather slender, nearly always glabrous but for the tip; number and arrangement of vascular strands in the pith very variable. *Stipules* subpersistent or caducous, inserted beside the petiolar base or rarely on the petiole up to 1¼ cm from the base, subulate, 1—10 mm. *Leaves* 0—6-jugate. *Leaflets* very variable, ovate to elliptic, rarely obovate or lanceolate, 4—30 by 2—10 cm, generally rather rigid, chartaceous to coriaceous, glabrous to more or less pubescent, specially beneath; base rounded to cuneate, slightly oblique; margin entire, in young plants often serrulate to dentate and with tufts of hair on the teeth; apex mostly more or less abruptly, up to *c.* 2 cm long, tapering to narrowly, acutely to bluntly acuminate; nerves rather prominent beneath, 7—20 pairs (angle 50—80°), straight to slightly curved, sometimes abruptly arching close to the margin. *Inflorescences* axillary, spicate to thyrsoid, ♂ up to *c.* 40 cm long, ♀ ones 1—20(—32) cm, mostly slender and flexible, pendulous to ascending, sometimes rigid and erect; more or less hirsutely pubescent to glabrous. *Flowers* 3—7 mm long, ♀ ones very rarely with a slightly concave receptacle. *Calyx* 1½—5 mm high. *Stamens* glabrous, 1½—5 mm long, free, rarely slightly connate at the base or adnate to the disk. *Disk* pilose, in the ♀ flowers 3- or 6-lobed to subtruncate, *c.* 1 mm high; in the ♂ flowers cup-shaped with sometimes a small ovarial rudiment, to subglobose, with or without a central canal, more or less 6-lobed, up to 1½ mm high. *Pistil* pubescent, rarely glabrous. *Infructescences* (sub)spicate, flexible to rigid, with many fruits; *calyx c.* 2½—5 mm diam. with strongly reflexed lobes (*asperum*-type) to *c.* 1 cm diam., funnel-shaped, deeply 3-lobed (*calophyl-*

lum-type). *Fruits* ovoid to subglobose, subacute, round or slightly trigonous in cross-section, 9—14 by 4—11 mm, glabrous; pyrene smooth to slightly rugose, rarely very faintly 6-ribbed; lids *c.* 2 mm thick. *Seed* 1; sterile cells entirely reduced or nearly so.

Distribution: Bawean & Kangean Islands near E. Java, Lesser Sunda Islands (Sumbawa, Sumba, Flores; according to Meijer Drees also in Timor), Borneo (apparently rare), Philippines, Celebes, Moluccas, New Guinea, and Solomon Islands.

Taxonomy. Extremely variable species, the infraspecific taxonomy of which is not yet clear, however abundant the material may be. The subdivision given here is therefore but a tentative one.

KEY TO THE INFRASPECIFIC TAXA

1.a. Inflorescences spicate to narrowly thyrsoid . . . . var. **asperum**
b. Inflorescences more widely branched 2
2.a. Inflorescences compoundly spicate . . . . var. **clementis**
b. Inflorescences thyrsoid . . . . subsp. **papuanum**

A. Subsp. **asperum**. — All synonyms with the exception of *C. papuanum*.

Inflorescences either spicate to (♂) narrowly thyrsoid, or compoundly spicate.

a. var. **asperum**. — All synonyms of the subsp. except those mentioned under var. *clementis*.

Inflorescences spicate or narrowly thyrsoid. In all other characters nearly as variable as the species.

Distribution: As the species.

JAVA. Kangean Islands: *Backer 27578 (= 27864?), 27823, 27864; Beguin F 2*. — Bawean: *Buwalda 2998, 3141; Karta 49.*

LESSER SUNDA ISLANDS. Sumbawa: *FRI. bb. 10322; De Voogd 1710; Warburg 17060* (type *C. tamborae* Laut.); *Zollinger 3424* (type *C. zollingeri* Engl.). — Sumba: *Iboet 78, 451*. — Flores: *Elbert 4312; FRI. bb. 8228, bb. 8930, bb. 9985, bb. 11369, bb. 21432.*

BORNEO. *Castro & Melegrito 1433; Kostermans 4678; NBFD. 4956 (Keith), SAN 16404 (Wood & Charington), SAN A 4194 (Wood), SH 10277 (Valera).*

PHILIPPINES. Palawan: *BS. 736 (Foxworthy), 910 (Foxworthy), 77884 (Edaño); Ebalo 500; Elmer 12658, 13228; FB. 3605 (Curran), 3788 (Curran), 3805 (Curran), 4145 (Curran), 29183 (Cenabre); Marche 89; Merrill 723* (type *C. polyneurum* Perk.), *9206, 9232, 9579; PNH. 12 (Edaño), 207 (Edaño 512), 12330 (Sulit 3765), 13375 (Fox 55), 14176 (Edaño 2672), 23050 (Celestino & Ramos 157)*. — Culion: *Herre 1008, 1017; Merrill 663*. — Mindoro: *BS. 15307 (Kienholz 323), 39674 (Ramos), 40680 (Ramos & Edaño); Merrill 2256* (syntype *C. thyrsoideum* Perk.); *PNH. 17478 (Conklin 122); Whitford 1480*.— Babuyan Islands: *FB. 26630 (Velasco)*. — Luzon: *Adduru 137; Ahern's coll. Decades 110; Bartlett 14550; BS. 480 (Fénix), 7200 (Ramos), 11157 (MacGregor), 11173 (MacGregor), 13878 (Ramos)* (type *C. heterophyllum* Merr.), *13958 (Loher), 14945 (Ramos)* (type *C. lagunense* Merr.), *17764 (Otanes), 20468 (Ramos)* (paratype *C. lagunense* Merr.), *20579 (Ramos)* (paratype *C. lagunense* Merr.), *23634 (Ramos), 26839 (Edaño), 29037 (Ramos & Edaño), 29627 (Ramos & Edaño), 29770 (Ramos & Edaño), 46541 (Ramos & Edaño), 76944 (Ramos), 78177 (Quisumbing), 82308 (Quisumbing); Clemens 16739, 18059; Cuming 689* (type *C. cumingii* Engl.), *769* (type *C. luxurians* Engl.), *1006* (type *C. minutiflorum* Engl.); *Elmer 8255, 8557, 8766, 8876, 8926, 9234, 15659, 17586, 18312, 22364; FB. 125 (Barnes), 697 (Borden), 1284 (Borden), 1311 (Borden), 1312 (Borden), 1314 (Borden), 1319 (Borden), 1554 (Borden), 1676 (Borden), 2789 (Meyer), 3146 (Ahern's coll.), 7108 (Klemme), 7667 (Curran), 10794*

(Curran), 10896 (Curran), 11973 (Tamesis), 11982 (Tamesis), 12927 (Alvarez), 12969 (Alvarez), 13964 (Merritt & Darling), 15207 (Bernardo), 17622 (Curran), 17745 (Curran), 18348 (Alvarez), 18586 (Alvarez), 19701 (Whitford), 20138, 21292 (Sandkuhl), 21681 (Domingo), 21957 (Adduru), 22818 (Diaz & Alambra), 23862 (Paraiso), 24218 (Lopez), 25403 (Labitag), 25422 (Duldulao), 26282 (Paraiso), 26510 (De Mesa & Magistrado), 26997 (De Guzman), 27781 (Ranario), 28410 (Valdez), 28604 (Salvoza), 28605 (Salvoza), 29042 (Velasco), 30427 (Sulit & Co.), 30851 (Oro), 31072 (Oro); Fénix 186; Galutera in herb. L 956.072—871; Loher 430, 431, 433, 439, 5855; Merrill 1056 (type *C. lucidum* Perk.), *1858* (type *C. calophyllum* Perk.), *1974* (type *C. juglandifolium* Perk.), *2119* (syntype *C. thyrsoideum* Perk.), *2129, 2348, 2556, 2821, 2864, 2936, Species Blancoanae 558; Otanes 2063; PNH. 4587 (Alcasid & Edaño), 6975 (Sulit), 6976 (Sulit), 9733 (Canicosa 170), 17947 (Edaño 5112), 33442 (Rañeses), 33481 (Orden Jr.), 33486 (Rivera), 33492 (Agra); Ramos 353, 1880; Sulit & Students 18; Vidal 174, 701, 1025, 1337, 1343, 1346, 1347, 2282, 2285, 2294, 2295; Whitford 74, 296, 376, 1154, 1309; Williams 553, 1373.* — Sibuyan: *Elmer 12095, 12225* (type *C. sibuyanense* Elm.). — Masbate: *Merrill 2617* (type *C. barnesii* Merr.), *2756, 3083.* — Samar: *BS. 24149 (Ramos)* (paratype *C. samarense* Merr.), *24191 (Ramos)* (type *C. samarense* Merr.), *24214 (Ramos)* (paratype *C. samarense* Merr.), *24385 (Ramos), 24479 (Ramos), 24879 (Edaño)* (paratype *C. samarense* Merr.); *FB. 24585 (Phasis); PNH. 6178 (Sulit), 6331 (Sulit), 14421 (Sulit 4261), 14427 (Sulit 4269), 14493 (Sulit 4333), 14507 (Sulit 4355).* — Leyte: *Vidal 159; Wenzel 293* (type *C. euphlebium* Merr.), *1388, 1394, 1725.* — Bohol: *BS. 42855 (Ramos).* — Cebu: *FB. 6412 (Espinosa), 6447 (Everett), 15252 (Cenabre).* — Negros: *Britton 346; Elmer 9630, 10113.* — Panay: *BS. 42449 (Edaño), 42451 (Edaño), 46184 (Edaño).* — Guimaras: *FB. 282 (Gammill); Vidal 2290.* — Sulu Islands: *Santos 4771.* — Mindanao: *BS. 34720 (Ramos & Pascasio)* (type *C. unifoliolatum* Merr.), *35088 (Ramos & Pascasio), 35178 (Ramos & Pascasio), 37264 (Ramos & Edaño), 38458 (Ramos & Edaño), 48862 (Ramos & Edaño), 48889 (Ramos & Edaño), 48906 (Ramos & Edaño), 49443 (Ramos & Edaño), 83954 (Ramos & Convocar), 83956 (Ramos & Convocar); Clemens 1150* (type *C. reticulatum* Merr.); *Elmer 11096, 11638* (type *C. apoensis* Elm.), *11859* (type *C. ogat* Elm.), *13275* (type *C. agusanense* Elm.), *13947* (type *C. subvelutinum* Elm.), *14074* (type *C. urdanetense* Elm.); *FB. 11884 (Miranda), 15227 (Klemme), 17993 (Miranda), 20774 (Miranda), 22459 (Klemme), 24169 (Miranda), 24472 (Miras, Sabino & Oliveros), 26602 (Ceballos), 27712 (Angeles & Selorio), 31043 (Aguilar), 31223 (Ponce, Logan & Vega); Kanehira 2490, 2603; PNH. 11093 (Edaño 1696); Wenzel 2597, 2608, 2615, 3093, 3223, 3374.* — Exact locality unknown: *Vidal 161, 1334, 1338.*

CELEBES. *Beccari herb. 2178; Elbert 3443; FRI. bb. 5428, bb. 6650, bb. 12656, bb. 15128, bb. 17047, bb. 17504, bb. 21109 (Waturandang 36), bb. 21308 (Waturandang 63), bb. 22952 (Van der Star 9), bb. 24706, bb. 31866, bb. 31911; Hort. Bot. Bog. VI D 3; Koorders (all β numbers) 16298* (syntype *C. treubianum* Engl.), *16300, 16305* (syntype *C. treubianum* Engl.), *16310* (syntype *C. treubianum* Engl.), *16315* (syntype *C. treubianum* Engl.), *16317* (syntype *C. treubianum* Engl.), *16318* (type *C. solo* Engl.); *Lam 2437; Noerkas 377; Teysmann 12225, 12786; De Vriese 80, 136; Warburg 15419.*

MOLUCCAS. Talaud: *Lam 2580.* — Morotai: *Anang 311; FRI. bb. 33735 (Tangkilisan 23), bb. 33861 (Tangkilisan 174), bb. 33880 (Tangkilisan 207), bb. 33918 (Tangkilisan 248); Lam 3505; Main & Aden 795, 935, 936, 946, 1440, 1505, 1545.* — Halmaheira: *FRI. bb. 24912.* — Ternate: *Beguin 2a.* — Batjan: *Teysmann in herb. L 898.319—197/8, in herb. L 898.319—310.* — Sula Islands: *FRI. bb. 28783, bb. 28857, bb. 29784, bb. 29871.* — Ceram: *Eyma 2806; FRI. bb. 17554, bb. 19652, bb. 25894, bb. 31933 (Salverda 6).* — Ambon: *Robinson Pl. Rumph. 376, Pl. Rumph. 377; Zippelius 238a.* — Exact locality unknown: *Hochreutiner Pl. Bog. Exsicc. 120; Hort. Bot. Bog. VI B 90a; Unknown coll. in herb. L 898 319—196* (type *Pimela denticulata* Bl.).

NEW GUINEA. *Aet 305; BW. 1156 (Koster), 1853 (Schram), 2518 (Brouwer), 2624 (Brouwer), 3190 (Stefels), 4502 (Lasschuit 5603), 4604 (Versteegh); Carr 12188, 12777; Docters van Leeuwen 10310; FRI. bb. 33335 (Kostermans 102), bb. 33346 (Kostermans 117), bb. 33347 (Kostermans 118), bb. 33604 (Kostermans 447); Kanehira & Hatusima 11460; Kostermans 104, 113; Ledermann 7345* (syntype *C. papuanum* H. J. Lam), *7743* (type *C. fulvum* Lauterb.); *Van Royen 3404; Zippelius in herb. L 898.319—302, 304* (type *Pimela legitima* Bl.).

SOLOMON ISLANDS. Bougainville: *Kajewski 1572; Waterhouse 89, Y 89.* —

Guadalcanal: *Kajewski 2462.* — Malaita: *Kajewski 2356.* — San Cristoval: *Brass 2824.*

cultivated:

Boivin s. n., Jard. bot. de Bourbon (type *C. molle* Engl.); *Loher 430 A, Jard. bot. Manila.*

Ecology: Apparently common in primary and secondary forests on very different, dry to wet, sometimes marshy, soils, sometimes found in more open forests or savannahs. Mainly occurring at low altitudes, up to *c.* 500 m, more rarely, mainly in the Philippines, found at altitudes above 1000 m (up to 1800 m). *Fl. fr.* chiefly March—Oct.

Wood anat.: Reyes, Dep. Agr. & Comm. Manila, Techn. Bull. 7 (1938) 161, pl. 24 fig. 3 (hand lens); Webber, Lilloa 6 (1941) 450.

Uses. The wood is said to be moderately hard, sometimes hard to very hard, or rather soft; it is of little durability. The resin is locally used for fuel and lighting purposes and sometimes recorded as caulking material for canoes and for painting hats. For the composition of the resin see Brown, *l. c.* (under *C. villosum*).

Notes. The type variety of this extremely variable species is also polymorphous itself. It consists of a number of local races, which are usually not sharply demarcated. The most common form, which has the same distribution as the species, is forma *villosum* (Bl.) H. J. Lam, characterized by its relatively large and nearly glabrous leaflets, its long and slender inflorescences and infructescences, and its small ovoid fruits.

The typical *C. asperum*, which is restricted to the Moluccas and New Guinea, is easily distinguishable by its rigid inflorescences and infructescences and fruits which are slightly larger than in forma *villosum.*

Closely related to the latter is forma *triphyllum* H. J. Lam (*in* Leenhouts, 1955b, 189), known only from Borneo, Morotai, and Ternate, a rather peculiar form with stiff trifoliolate leaves.

As is shown by the abundance of synonyms there is a surprising variability, especially in the vegetative parts, in the Philippine Islands. It is possible to distinguish quite a number of forms, all of which are related to forma *villosum.* As most of them are only vaguely demarcated, it is no use mentioning them all. The most extreme ones are: *C. lucidum* Perk., a small tree with 2-jugate leaves and small (4—7—11 by 2½—3—5½ cm), coriaceous leaflets, main nerves 8—11 pairs, collected in Luzon at high altitudes; *C. urdanetense* Elm., with unifoliolate, rarely 1-jugate, small (leaflet 6—7 by 2½—3 cm) leaves, the leaflet convex, main nerves prominent beneath, once collected in Mindanao at high altitudes; *C. reticulatum* Merr., with rather large, coriaceous, bullate leaflets, nerves sunken above, strongly prominent beneath, costa above and nerves beneath rather densely hirsutely pilose, margin serrulate; known from Samar, Leyte, Panay, and Mindanao, at medium altitudes.

Most of the Philippine specimens, and especially the more extreme ones, are characterized by a fruiting-calyx of the *calophyllum*-type and by slightly larger, ellipsoid fruits (*c.* 15 by 9 mm); in these respects they remotely resemble *C. vrieseanum.*

C. luxurians Engl. was based upon a specimen with witches' brooms in the inflorescences, a feature which is common in this species, and which is furthermore only known to occur in *C. acutifolium.* They represent very dense, sterile structures, up to 25 cm diam.

Although *C. fulvum* Laut. is possibly conspecific with *C. schlechteri* rather than with the present species, I prefer to include it in *C. asperum,* being the more variable and more common species. The type specimen consists only of young leaves and ♂ flowers which are intermediate between the two species. *C. schlechteri* is characterized by its adult leaves, its fruits and its sometimes more specialized ♂ flowers.

b. var. **clementis** (Merr.) Leenhouts, 1956, 295. — *C. clementis* Merr. — *C. leytense* Elm. — *C. wenzelii* Merr.

Type: Philippines, Mindanao, Lake Lanao, Camp Keithley, March 1907, *Clemens s. n.,* ♂ and fr., lectotype (PNH †; isotype in G).

Leaves 3—4(—5)-jugate. Leaflets medium-sized (10—17 by 5—8 cm), glabrous to densely ferruginously tomentose beneath; nerves 15—20 pairs; veins transverse, dense. Inflorescences compoundly spicate, flowers in glomerules.

Distribution: Philippines (Luzon, Leyte, Mindanao).

PHILIPPINES. Luzon: *Vidal 1341* (aff.); *Williams 641.* — Leyte: *Elmer 7274* (type *C. leytense* Elm.); *Wenzel 351* (type *C. wenzelii* Merr.). — Mindanao: *Elmer 11730* (type *C. clementis var. perumbrinum* Elm.); *Wenzel 2670.*

CELEBES. *Rachmat 685* (aff.).

B. Subsp. **papuanum** (H. J. Lam) Leenhouts, 1955a, 12; 1956, 295. — *C. asperum* Benth.; Lauterbach, 1912, 827; 1920, 327. — *C. papuanum* H. J. Lam.

Type: New Guinea, Nassau Mts, Explorator's bivouac, Oct. 1926, *Docters van Leeuwen 10536,* ♂, lectotype (BO; isotype in L).

Inflorescences more widely and laxly thyrsoid.

Distribution: New Guinea, (low to) 1000—1800 m.

NEW GUINEA. *Clemens 3798, 4731, 6643; Docters van Leeuwen 10536* (lectotype *C. papuanum* H. J. Lam); *Gjellerup 118* (syntype *C. papuanum* H. J. Lam); *Ledermann 10630, 10909; NGF. 1278 (Smith).*

Notes. Insufficiently known taxon, which for the time being had probably best be inserted here.

Fairly variable in its vegetative and its flower parts. The ovariodisk in the ♂ flowers is quite variable in shape: the toadstool-shaped one, mentioned by H. J. Lam, is not typical, as I have also observed it in some Philippine specimens of subsp. *asperum.* The triangular shape of the fruits, also mentioned by H. J. Lam, though looking quite different from subsp. *asperum,* is in my opinion of minor importance, as they are all young or sterile.

Docters van Leeuwen 10536 is said to have been collected of a climbing plant.

Note. The species as a whole is best characterized by the small, ovoid to ellipsoid fruits, though these are not very different from those of *C. oleosum* and *C. acutifolium.* Var. *asperum,* moreover, is characterized by its often spicate inflorescences and infructescences.

62. **Canarium schlechteri** Lauterbach, 1920, 328; Lam, 1932a, t. 12

f. 87, t. 15 f. 117c; 1932b, 454, t. 10 f. 62; Leenhouts, 1956, 296, f. 20e. — *C. gutur* De Miklouho-Maclay, 1885, 353, 357, *nom. nud.*

Type: N.E. New Guinea, Djamu River, alt. 250 m, Nov. 25, 1907, *Schlechter 16884,* ♂ (B †; isotypes in BRSL, L, P).

Tree up to 25 m by 30—40 cm, sometimes faintly buttressed. *Branchlets* slender, glabrescent; pith with many rather small vascular strands, peripheral ones distinctly, central ones more or less distinctly, cylindrically arranged. *Stipules* inserted on the petiole up to 3 cm from the base, rather caducous, filiform, 2—3 mm. *Leaves* 3—6-jugate, glabrous to about woolly pubescent. *Leaflets* ovate to lanceolate, (5—)12—20 by (3—)5—7 cm, subcoriaceous, glabrous or thinly puberulous on the midrib above and on the nerves beneath; base slightly oblique, rounded to subcordate, sometimes attenuate; margin entire; apex acute, more or less abruptly short acute-acuminate; nerves 11—20 pairs (angle 50—60°), straight to slightly curved, not to distinctly and abruptly arching near the margin, nerves and veins often slightly sunken above, prominent beneath; intermediate veins not rarely well developed. *Inflorescences* (♀ unknown) axillary, narrowly thyrsoid, 12—22 cm long, sparsely tomentose to glabrous, main branches up to 1½ cm, up to 9-flowered; *bracts* subpersistent, subulate, up to 8 mm. ♂ *Flowers* (♀ unknown) slender, 8—9 mm long, short-stalked. *Calyx* nearly truncate, 3 mm high, tomentose to scabrous. *Stamens* 7—8 mm long, glabrous, irregularly confluent at the base for up to 2 mm, tube more or less adnate to the disk. *Disk* 3 mm high, narrowly cupular to cylindrical, rim pilose, truncate to somewhat undulate, rudimentary ovary minute. *Infructescences* axillary, up to *c.* 10 cm long, glabrous, with 1—3 fruits; calyx saucer-shaped, triangular, 1 cm diam.; remains of the disk 1 mm high, slightly 6-lobed, fimbriate. *Fruits* fusiform, acute, round to slightly triangular in cross-section, 4 by 2 cm, glabrous; pyrene acutely 6-ribbed to deeply furrowed all over the surface; lids *c.* 3 mm thick; cells small, elliptic to round. *Seeds* 1—2.

Distribution: E. New Guinea and New Britain.

NEW GUINEA. *Brass 24141; Forbes 77; Hoogland 3856, 4195, 4605, 4976; NGF. 1328 (Smith), 2929 (Womersley), 8646 (Womersley & Brass); Saunders 43; Schlechter 16884* (type).

NEW BRITAIN. *NGF. 1879 (Mair), 1897 (Mair), 3426 (Womersley), 6614 (Floyd).*

Ecology: Rain-forests up to 250 m, *fl.* June, Aug., and Nov., *fr.* March, May—Sept.

Uses. Produces a damarlike resin. The seeds are edible.

Note. See for the identity of *C. fulvum* Laut. under *C. asperum.*

63. **Canarium acutifolium** (DC) Merrill, 1917, 302; Lam, 1932a, t. 11 f. 58, t. 13 f. 104j, t. 15 f. 117b; 1932b, 451, t. 10 f. 61; Lam & Husson, 1952, 164; Chattaway, 1953, 30, f. 3; Leenhouts, 1956, 291, f. 22c. — *Dammara nigra* Rumphius. 1741, 160, t. 52. — *? C. nigrum* Roxburgh, (1814, 49, *nom. nud.*), 1832, 138. — *Marignia acutifolia* De Candolle, 1825, 79; Henschel, 1833, 116. — *Pimela acutifolia* Blume, 1850, 221. — *Pimela laxiflora* Blume, 1850, 221. — *C. longiflorum* Zippelius *ex* Miquel, 1859, 647; Engler, 1883, 125. — *C. rostratum* Zippelius *ex* Miquel, 1859, 647, *nom. illeg.*; Engler, 1883, 128. — *C. lineistipula* K. Schumann & Lauterbach,

1901, 379; Lauterbach, 1920, 331; Lane-Poole, 1925, 98. — *C. aemulans* Lauterbach, 1920, 326, f. 2 F—O; Engler, 1931, f. 213 F—O; Lam, 1932a, t. 12 f. 81; 1932b, 453. — *C. legitimum* (*non* Miq.) Heyne, 1927, 877, *pro maj. parte.* — *C. leeuwenii* H. J. Lam, 1932a, 210; 1932b, 449, t. 9 f. 59.

Type: New Guinea, *Zippelius 194,* ♀ & fr., neotype (L; isotypes in BRSL, U).

Tree, 20(—40) m by 20—90 cm; buttresses, if present, up to 3 m high. *Branchlets* up to 1½ cm thick, soon glabrescent; pith with a peripheral cylinder of vascular strands, closely appressed to the wood-cylinder, sometimes moreover some scattered ones in the central part; central part nearly always disappearing (very probably by the action of ants). *Stipules* subpersistent, inserted at the base of the petiole, filiform, 1—3½ cm long. *Leaves* (2—)3—5(—7)-jugate. *Leaflets* ovate to narrowly oblong, 7—30 by 4—11½ cm, chartaceous, glabrous; base slightly oblique, rounded to broadly cuneate; margin entire; apex rather long and slender (¾—2 by ¼ cm) blunt-acuminate; nerves 11—25 pairs (angle 80—90°), slightly, towards the margin more strongly, curved, more or less distinctly arching close to the margin. *Inflorescences* axillary, laxly pyramidal-thyrsoid, nearly always glabrous, ♂ ones up to 50 cm, ♀ ones up to 40 cm long, main branches up to 20 cm, partial panicles long-stalked, many-flowered. *Flowers* c. 4 mm long, shortly pedicelled, (sub)glabrous outside, ♀ ones with a slightly concave receptacle. *Calyx* 2—2½ mm high. *Stamens* 3 or 6, free, glabrous. *Disk* glabrous, in ♂ flowers irregularly shaped, 1½ mm high, with a central canal in which the minute rudimentary pistil is immersed; in ♀ flowers a faintly 3—6-lobed rim, 1 mm high. *Infructescences* like the inflorescences, rigid, with many fruits; calyx flat, triangular, 3—6 mm diam., tips of the lobes reflexed. *Fruits* see varieties. *Seed* 1, sterile cells strongly reduced.

Distribution: Central Celebes, Moluccas, and New Guinea.

Taxonomy. The following varieties are distinguishable:

KEY TO THE VARIETIES

1.a. Stamens 3 . . . . var. **acutifolium**
b. Stamens 6 2
2.a. Nerves 20—25 pairs . . . . var. **celebicum**
b. Nerves 12—15 pairs . . . . var. **aemulans**

a. var. **celebicum** Leenhouts, 1955b, 188; 1956, 292.

Type: Celebes, Menado, Palu, Sidaunta, alt. 400 m, July 13, 1939, *FRI. bb. 28279,* ♀ (L; isotypes in A, SING).

Branchlets solid; pith with a peripheral cylinder of vascular strands and some scattered ones in the central part. Stipules inserted on the petiole at 1—5 mm from the base, up to 1½ cm. Leaflets oblong to lanceolate, 10—22 by 4—6 cm; the apex more gradually narrowed; nerves 20—25 pairs, nearly straight. Inflorescences and flowers (♂ unknown) thinly tomentose. Stamens 6. Disk 6-lobed, pilose as is the pistil. Fruit-calyx 5—6 mm diam. Mature fruits unknown.

Distribution: Central Celebes.

CELEBES. *FRI. bb. 28279* (type), *Cel./V-190* (paratype), *Cel./V-310* (paratype).

Ecology: Collected at 250—400 m; *fl.* July.

Note. A specimen from the Solomon Islands, Bona (*BSIP. 364, Naqu*) seems to be very close to this variety. It mainly differs by the strongly articulated bases of the petioles, the rather long stipules, inserted at the base of the petiole or on the twig (so as in var. *acutifolium*) and the number of nerves (12—18 pairs); the fruits are different from those of var. *acutifolium* and *aemulans*, being ellipsoid, 2 by 1 cm, the stone with 6 faint ribs, and with 1 or 2 seeds developing (the fruits of var. *celebicum* are still unknown). As the material is rather insufficient, I hesitate to describe it as a new variety, let alone a new species.

b. var. **aemulans** (Laut.) Leenhouts, 1956, 292. — *C. aemulans* Laut.

Type: N.E. New Guinea, Kani Mts, alt. 1000 m, May 26, 1908, *Schlechter 17779*, ♂, lectotype (B †; isotypes in BR, BRSL, K, L, P).

Differing from var. *celebicum* in its leaflets, which are ovate to oblong, 7—18 by $3\frac{3}{4}$—$8\frac{1}{2}$ cm, gradually to abruptly acuminate, and with 12—15 pairs of nerves. Inflorescences often smaller. Fruits subglobular, $1\frac{3}{4}$ by $1\frac{1}{2}$ cm; sterile cells less reduced.

Distribution: New Guinea and New Britain.

NEW GUINEA. *BW. 2739 (Schram); Carr 14261, 14482; Schlechter 17587* (syntype), *17779* (lectotype).

NEW BRITAIN. *NGF. 6670 (Floyd), 6674 (Floyd).*

Ecology: Up to 1000 m, *fl. fr.* Dec.—May.

c. var. **acutifolium**. — Synonymy as the species with the exception of *C. aemulans*.

Branchlets nearly always becoming hollow. Stipules inserted at the base of the petiole, $1\frac{1}{2}$—$3\frac{1}{2}$ cm long. Leaflets 12—30 by 4—$11\frac{1}{2}$ cm; the apex abruptly acuminate; nerves 11—15—20 pairs. Inflorescences and flowers nearly always glabrous. Stamens 3. Pistil glabrous. Fruit-calyx 3—$3\frac{1}{2}$ mm diam. Fruits ovoid, acute, round in cross-section, 12—15 by 8—10 mm, glabrous; pericarp thin; pyrene tuberculate; lids $1\frac{1}{2}$—2 mm thick.

Distribution: Moluccas (Kei Islands, according to Rumphius also on Manipa, Kelang, Ceram, and Ambon), New Guinea (incl. also P. Japen, Waigeo, Misool, and Aru Islands).

MOLUCCAS. *Jaheri 476.*

NEW GUINEA. *Aet 259, 420; Beccari herb. 2180, herb. 2181; Brass 5834, 8201; BW. 19 (Versteegh 21), 295 (Koster 15), 367 (Bouwer 15), 496 (Schram 49), 651 (Mangold), 740 (Versteegh), 1139 (Koster), 2099 (Mangold 43), 2546 (Brouwer), 3522 (Kalkman); Carr 11619, 12877, 16517; Docters van Leeuwen 9854, 10643* (type *C. leeuwenii* H. J. Lam), *11090, 11312, 11393; FRI. bb. 25270, bb. 25356, bb. 30564, bb. 33302 (Kostermans 58), bb. 33303 (Kostermans 60); Hoogland 3265, 3508, 3896, 4526, 4532, 5024; Hoogland & Floyd 3815; Kanehira & Hatusima 12627, 12628; Kostermans 304, 2655; Lane-Poole 197, 306; Ledermann 8806, 12326; Macadam 3; Moszkowski 253, 255; NGF. 865 (Cavanaugh), 1226 (Smith), 1719 (Smith), 1730 (Smith), 2030 (Cavanaugh & Fryar), 2409 (Cavanaugh & Fryar), 3677 (Womersley), 3809 (Womersley), 4544 (Hart), 4581 (Jackson & MacDonald), 5802 (Womersley), 8047 (Gray & Floyd), 8092 (Gray), 8159 (MacDonald); Pleyte 1018, 1020; Pulle 292; Roditz & Klink 231* (type *C. lineistipula* K. Sch. & Laut.); *Van Royen 3824, 5265, 5300; De Zeeuw 19, 45; Zippelius 157* (type *C. longiflorum* Zipp. and *Pimela laxiflora* Bl.), *194* (neotype *Marignia acutifolia* DC.).

Ecology: In New Guinea apparently the most common species of the genus, both in primary and in secondary forests, specially in more open places (forest-edges, river-banks, clearings), mostly on wet (sometimes temporarily inundated) clayey soil, up to *c.* 200(—700) m. *Fl.* mainly July—Sept., *fr.* mainly Jan.—March.

Uses. Wood rather soft to very hard, tough, but easily splitting. The resin, though abundant, seems to be of little importance; it is used for lighting purposes and for caulking boats.

Notes. I have included *C. leeuwenii* H. J. Lam in this variety. The only specimen known of this is *Docters van Leeuwen 10643*; it bears very young fruits and differs from the typical *C. acutifolium* by its dense, hirsute, reddish-brown tomentum. The hairiness is very variable in most species of *Canarium,* and this specimen was collected at a rather high altitude (700 m).

Pleyte noted on his *no.* 1020 from Misool that the specimen was a pseudoliana 30 m by 4 cm; other collections from him in adjacent localities are, however, made from trees; I have my doubts about this field note.

Notes. The inflorescences of this species sometimes develop witches' brooms like those of *C. asperum.*

Apparently var. *celebicum* is the most primitive (6 stamens), var. *acutifolium* the most specialized form of this species (3 stamens); var. *aemulans* is intermediate between the two forms: nearly identical with var. *acutifolium*, though with 6 stamens. The species as a whole is closely related to *C. asperum* ssp. *papuanum.*

C. acutifolium is best characterized by the very long and filiformous stipules and by the large, widely thyrsoid inflorescences and infructescences, with small flowers and fruits, the latter resembling those of *C. asperum.* Moreover, the usually hollow twigs, and the leaflets, which are greyish-green and shining when dry, rather coarsely prominulous reticulated, and with a rounded, rather abruptly short- and blunt-acuminate apex, are typical.

64. Canarium macadamii Leenhouts, 1955b, 191, f. 5c; 1956, 289.

Type: N.E. New Guinea, Morobe Distr., Wau, alt. 1500 m, *J. B. McAdam 206,* ♂ & loose fr. (BRI; isotypes in L, LAE).

Large tree, *c.* 30 m by 75 cm. *Branchlets* slender, somewhat scabrous, lenticellate; pith with a peripheral cylinder of vascular strands, central ones more or less clearly cylindrically arranged. *Stipules* caducous, inserted at the base of the petiole, linear, 5—6 mm, glabrous, as are the leaves and the inflorescences. *Leaves* 2—4-jugate. *Leaflets* oblique-ovate, 12—18 by 6—9 cm, (sub)coriaceous; base oblique, rounded; margin entire; apex abruptly, short (5 mm) blunt-acuminate; nerves 14—16 pairs (angle 60—70°, in the basal part up to 90°), straight to slightly curved, vaguely to distinctly arching close to the margin. *Inflorescences* (♀ unknown) axillary, narrowly thyrsoid, *c.* 12 cm long; branches up to 2½ cm, with up to 15 clustered flowers. *Flowers* (♂) 7 mm long, short-pedicelled, glabrous outside, with a slightly concave receptacle. *Calyx* 4½ mm high. *Stamens* slightly confluent at base. *Disk* conical, 1½ mm high, halfway with a 6-lobed rim, glabrous, with a central canal, widening to the base and enclosing the rudimentary pistil. *Infructescences c.* 8 cm long, with 1 to few fruits; calyx flat, triangular, 5 mm diam., lobes reflexed. *Fruits* ellipsoid, round in cross-section, 3½ by

1½—2 cm, acuminate at the apex, glabrous; pyrene smooth; lids 3 mm thick. *Seed* 1, sterile cells moderately reduced.

Distribution: New Guinea (Morobe Distr.).

NEW GUINEA. *Macadam 206* (type).

Ecology: Forested slope, on rich clay or loam soil, locally common, 1500 m.

Note. Doubtless closely related to *C. acutifolium*, specially to its var. *aemulans.* Different by its larger flowers, and especially by the larger, more spindle-shaped fruits.

65. **Canarium chinare** Grutterink & H. J. Lam, *in* Leenhouts, 1955a, 7, f. 4; Leenhouts, 1956, 289.

Type: Solomon Islands, Bougainville, alt. 950 m, Aug. 12, 1930, *Kajewski 2089*, fr. (A; isotypes in BISH, BO, BRI, G, L, P, SING).

Tree up to 25 m. *Branchlets* slender, scabrous, tips sparsely appressedly pubescent; pith with many vascular strands, partly arranged in a peripheral cylinder. *Stipules* caducous, inserted at the conjunction of petiole and branchlet on a faintly prominent 2—3 mm long rim, oblong-lingulate to subulate, 1½—6½ mm. *Leaves* 2—6-jugate, glabrous. *Leaflets* ovate to oblong-elliptic, 5—11 by 2—4½ cm, chartaceous to coriaceous; base cuneate, in laterals slightly oblique; margin entire; apex bluntly short-acuminate; nerves 8—14 pairs (angle 50—55°), nearly straight to faintly curved, more or less distinctly interarching close to the margin. *Inflorescences* and *flowers* unknown. *Infructescences* axillary, subracemose, 4—8 cm long, with 1—2 fruits; calyx saucer-shaped, 3-lobed, 8 mm diam.; remains of 6 fimbriate disk-lobes present. *Fruits* ellipsoid, 2 by ¾ cm, glabrous; pyrene irregularly grooved; lids *c.* 1½—2 mm thick. *Seed* 1; sterile cells nearly entirely reduced.

Distribution: New Guinea (Milne Bay Distr.), Admiralty Islands (Los Negros), and Solomon Islands (Bougainville).

NEW GUINEA. Milne Bay district: *Brass 21869.*
ADMIRALTY ISLANDS. Los Negros: *NGF 558 (Hepplethwaite).*
SOLOMON ISLANDS. Bougainville: *Kajewski 2089* (type).

Ecology: Rain-forests, up to 950 m. *Fr.* Febr.—Aug.

Notes. The alliance of this species seems to be especially with *C. macadamii* and *vanikoroense.*

The fruits are described from unripe ones from New Guinea. These are in good agreement with sterile fruits from Los Negros; the sterile fruits of the type specimen are slightly larger, however. The conspecificity of the type specimen on the one hand and both other specimens on the other is not beyond doubt.

66. **Canarium vanikoroense** Leenhouts, 1955a, 7, f. 3. — *C. linguistipulum* Leenhouts, 1955a, 5, f. 2.

Type: New Hebrides, Santa Cruz group, Vanikoro Isl., Sept. 25, 1928, *Kajewski 539,* ♂ (A).

Tree, 15—20 m high. *Branchlets* 6—13 mm thick, glabrous; pith with a peripheral cylinder of vascular strands. *Stipules* inserted at the conjunction of petiole and branchlet or on the latter up to 3 mm from its base, narrowly lanceolate, 6—7 mm long, inserted on a slight rim. *Leaves* 2—5-jugate.

Leaflets ovate, 8—17 by 3½—8 cm, coriaceous, glabrous; base of laterals slightly oblique, truncate to rounded; margin entire; apex rather abruptly bluntly acuminate; nerves 9—16 pairs (angle 90—60°, decreasing from base to apex), basal ones straight, the others more or less strongly curved, more or less distinctly interarching close to the margin. *Inflorescences* (♀ unknown) axillary, together sometimes pseudo-terminal, thyrsoid, 12—25 cm long, the few transverse branches up to 4 cm long, few-flowered, glabrous. *Flowers* (♀ unknown) 7 mm long. *Calyx* 5 mm, outside glabrous. *Corolla* densely appressedly pubescent. *Stamens* 6, glabrous, the filaments slightly more than halfway connate. *Disk* in ♂ flowers urceolate, slightly 6-lobed, 1 mm high, shortly and densely pubescent, with a narrow central canal, in ♀ flowers apparently consisting of 6 free, ciliate lobes. *Pistil* in ♂ flowers absent. *Infructescences* racemose to thyrsoid, 25—30 cm long, with 5—6 fruits; the calyx flat, faintly 3-lobed, 1.2—1.5 cm in diam. *Fruits* ovoid, more or less acute at both ends, 3¾ by 2 cm, glabrous except some scattered hairs near the apex; pyrene very rugose; lids 3—5 mm thick. *Seeds* 2; the sterile cell moderately reduced.

Distribution: New Hebrides (Santa Cruz group) and Fiji.

NEW HEBRIDES. Santa Cruz: Vanikoro Isl., *Kajewski 539* (type).

FIJI ISLANDS. Viti Levu: *Gillespie 3616; Tothill 422* (both paratypes of *C. linguistipulum* Leenh.), *513* (type *C. linguistipulum* Leenh.). — Vanua Levu: *Smith 6782* (paratype *C. linguistipulum* Leenh.).

Ecology: Rain-forests, 0—250 m. *Fl.* Sept., *fr.* May, Oct., and Dec.

Notes. The relationships of this species are apparently on the one hand with *C. chinare*, on the other with *C. smithii*. From the former species it mainly differs by its broader leaves and its bigger fruits, from the latter by its stipules and its connate stamens.

As only fruiting material of *C. linguistipulum* and one ♂ flowering specimen of *C. vanikoroense* are known at present, and these are not fully identical, the conspecificity of the two is not certain.

67. **Canarium smithii** Leenhouts, 1955a, 12, f. 6 — *C. vitiense* (*non* A. Gray) Degener, 1949, 266, 295. — *C. bacciferum* Leenhouts, 1955a, 19, f. 9.

Type: Fiji Islands, Vanua Levu, Mathuata, Seanggangga plateau, vic. of Natua, alt. 100—200 m, Nov. 25/Dec. 8, 1947, *A. C. Smith 6708*, ♂ (A; isotypes in K, L).

Tree, 7—30 m by up to 1½ m. *Branchlets* slender, glabrescent, becoming more or less scabrous; pith with a peripheral cylinder of vascular strands and usually a second cylinder in the central part. *Stipules* caducous, inserted at the base of the petiole or on the latter up to 1 cm from the base, subulate, 3—4 mm long, minutely fulvous pubescent. *Leaves* 2—5(—6)-jugate, more or less glabrescent. *Leaflets* elliptic, 3½—15 by 2½—6 cm, (sub)coriaceous, glabrous; base more or less oblique, rounded to broadly cuneate; margin entire; apex gradually to rather abruptly, shortly and bluntly acuminate; nerves 7—15(—*c.* 20) pairs (angle 60—85°), nearly straight to curved, more or less distinctly interarching close to the margin. *Inflorescences* axillary, glabrous, ♂ ones thyrsoid, 3—30 cm long, rather many-flowered, ♀ ones racemose. *Flowers* (♀ unknown) 1 cm long, densely appressedly pubescent. *Calyx* 3½—4 mm. *Petals* with a very distinct, inflexed apiculum. *Stamens*

6, confluent at the very base, glabrous. *Disk* cupular, ½ mm high, long-pilose. *Pistil* rudimentary, 0.1 mm. *Infructescences* (sub)racemose, 7—20 cm long, with 3—8 fruits; calyx flat, 3-lobed, 7—8 mm diam., the lobes spreading to slightly reflexed; remainders of a 6-lobed, pilose disk. *Fruits* ovoid to nearly globular, 16—22 by 14—17 mm; pyrene circular in cross-section, rugose; the lids 2 mm thick. *Seed* 1; sterile cells strongly reduced.

Distribution: Fiji Islands.

FIJI ISLANDS. Viti Levu: *Degener 15429* (paratype *C. bacciferum* Leenh.); *Gillespie 4248, 4267, 4359* (paratypes *C. bacciferum* Leenh.); *Greenwood 940* (paratype *C. bacciferum* Leenh.), *1102*; *Smith 5856* (paratype *C. bacciferum* Leenh.), *6275* (type *C. bacciferum* Leenh.), *8434, 9019*. — Ovalau: *Gillespie 4542* (paratype *C. bacciferum* Leenh.). — Vanua Levu: *Smith 6477* (paratype), *6708* (type).

Ecology: Forests, up to c. 1000 m. *Fl.* Sept.—Dec., *fr.* apparently Jan.—Dec.

Uses. The timber is sometimes used for construction.

Note. Related to *C. chinare, vanikoroense,* and *vitiense.*

68. **Canarium vitiense** A. Gray, 1854, 373 (*incl. var. b*); Seemann, 1865, 35; Engler, 1883, 134; Drake del Castillo, 1886, 135; Leenhouts, 1955a, 17, f. 8.

Type: Fiji, Vanua Levu, mountains of Mathuata coast, 1838/42, *Wilkes exp. s.n.*, fr. (GH; isotypes in K, P).

Shrub or tree (up to 20 m). *Branchlets* 3½—6 mm thick, youngest parts thinly tomentose, glabrescent; pith with a peripheral cylinder of many small vascular strands, central part with a few scattered ones. *Stipules* inserted at or on the base of the petiole, caducous, subulate, 2 mm long. *Leaves* 1—4-jugate, densely brown tomentose when very young, glabrescent. *Leaflets* elliptic, 5½—11½ by 3½—5¾ cm, herbaceous to thin coriaceous; base cuneate to rounded, slightly decurrent; margin entire; apex more or less abruptly bluntly acuminate; nerves 8—12 pairs (angle 70—80°), faintly curved, interarching near the margin; reticulations coarse, prominulous at both sides. *Inflorescences* ♂ axillary to pseudo-terminal, with up to 10 flowers, racemose to thyrsoid, 4½—12 cm long, youngest parts thinly minutely pubescent; ♀ axillary, racemose, 3—4 cm long, with up to 6 flowers. *Flowers* ♂ 12—13 mm long, ♀ 7 mm. *Calyx* ♂ 7—8 mm, ♀ 5 mm, both thinly pilose outside, densely, shortly, and appressedly pilose inside. *Corolla* outside densely shortly pilose. *Stamens* 6, slightly adnate to the disk, glabrous. *Disk* in ♂ flowers extremely variable, 1 mm high, either faintly 6-lobed and cupular, or an ovariodisk present, in the upper part always with long stiff spreading hairs, in ♀ flowers 6-lobed, ¾ mm high, not very thin, longciliate. *Pistil* in ♂ flowers strongly reduced to absent, in ♀ flowers densely and shortly pilose. *Infructescences* racemose, 7—12 cm long, with up to 6 fruits; the calyx funnel-shaped, 5—6 mm high, 8—12 mm in diam. *Fruits* fusiform, 1¾—3 by 1—1½ cm, glabrous except for some hairs at the apex; pyrene irregularly deltoid in cross-section, with some slight ridges; lids *c.* 1½ mm thick. *Seed* 1, sterile cells strongly reduced.

Distribution: Fiji Islands.

FIJI ISLANDS. Viti Levu: *Horne 686; Smith 7114, 9422.* — Ovalau: *Gillespie 4447, 4521, 4553; Seemann 97; Smith 7280, 8050.* — Vanua Levu: *Smith 6468; Wilkes s.n.* (type). — Koro: *Smith 996.* — Exact locality unknown: *Horne 218, 354.*

Ecology: In dense forest, up to 600 m. *Fl.* Jan., *fr.* apparently the whole year.

Uses. The fruits are eaten.

Note. Closely related to *C. smithii,* moreover related to *C. samoense.* Best characterized by its fusiform fruits, tapering at base and apex, and by the funnel-shaped calyx in fruit.

69. **Canarium samoense** Engler, 1883, 134; Christophersen, 1935, 113; Yuncker, 1945, 44; Leenhouts, 1955a, 22, f. 10. — *Canarium sp. nov.,* Horne, 1881, 285.

Type: Samoa Islands, *Powell 311,* fr. (K).

Rather large tree (up to 20 m). *Branchlets* 9 mm thick, glabrous; pith with many small vascular strands, the peripheral ones more or less cylindrically arranged. *Stipules* inserted at the base of the petiole, caducous, probably small and subulate. *Leaves* 3—6-jugate, glabrous. *Leaflets* broad-elliptic to elliptic-oblong, slightly oblique, 7½—14 by 3½—4½ cm, chartaceous (to coriaceous); base slightly oblique, rounded to cuneate, somewhat decurrent; margin entire; apex tapering blunt-acuminate; nerves (8—)13—16 pairs (angle 70—80°), faintly curved, more or less abruptly and distinctly interarching at some distance from the margin; reticulations coarse, prominulous at both sides. *Inflorescences* (♀ unknown) axillary, 6—11 cm long, few-flowered. *Flowers* (♀ unknown) 8 mm long. *Calyx* 5 mm, outside glabrescent. *Corolla* outside densely appressedly pubescent. *Stamens* 6, free, glabrous. *Disk* cupular, fleshy, *c.* 1½ mm high, glabrous. *Pistil* absent. *Infructescences* axillary, racemose, 6—13 cm long, with 1—3 fruits; calyx flat, 3-lobed, 1 cm in diam., outside glabrous, with remnants of an annular disk. *Fruits* ellipsoid to ovoid, 2½ by 1¼—1½ cm, acuminate at apex, glabrous; pyrene very rugged; lids 2 mm thick. *Seed* 1, sterile cells strongly reduced.

Distribution: Samoa Islands.

SAMOA ISLANDS. Savaii: *Christophersen 2770.* — Upolu: *Christophersen 290, 1833; Graeffe 1385.* — Exact locality unknown: *Horne 5; Powell 311* (type).

Ecology: Forests, up to 500 m. *Fl.* Sept., *fr.* March, Aug.

Uses. Resin used for embalming.

Note. Closely related to *C. smithii* and *C. vitiense.* Up to now, the material available is insufficient for giving a more definite circumscription of these three species, which vegetatively are almost indistinguishable. *C. vitiense* is well characterized by its differently shaped fruits; *C. smithii* and *samoense* differ slightly in their flowers and in the leaves. Only in the field may it be possible to decide, which ♂ and ♀ specimens and fruits belong together, and whether these three species are good ones, or are variants of one single species.

III. SECTION CANARIELLUM

Genus *Canariellum* Engler, 1896, 242. — Sect. *Canariellum* Leenhouts, 1955a, 40. — Subgen. *Canariellum* Leenhouts, 1956, 251.

Pith of the *branchlets* not rarely without vascular strands. No *stipules.*

Inflorescences axillary or terminal. *Stamens* usually free. *Pistil* often 2-celled. *Calyx* in fruit small.

Distribution: N.E. Australia and New Caledonia.

70. **Canarium baileyanum** Leenhouts, 1955a, 45, f. 19. — *Bursera australasica* F. M. Bailey, 1892, 8; 1895, 14; 1899, 223; 1909, 85, f. 71; Francis, 1922, 218. — *Protium australasicum* Sprague, 1912, 370; Francis, 1929, 175, f. 112—113; 1951, 200, f. 114—115; Lam, 1932b, 321. — *Santiria ? spec.* J. J. Swart, 1942, 393. — *Canarium australasicum* Leenhouts, 1952, 159, *nom. illeg.* — *non Canarium australasicum* Bentham and Mueller, 1863, 377 (= *Canarium australianum* F. Muell.).

Type: Queensland, Moreton Distr., Eumundi, May 1892, *J. F. Bailey & Simmonds s.n.*, fr. (K).

Tree, up to 40 m high. *Branchlets* 3—4½ mm thick, youngest parts ferruginously tomentose, glabrescent; pith without vascular strands. *Leaves* (unifoliolate to) 1(—3)-jugate, ferruginous-pubescent when young, glabrescent. *Leaflets* obovate to oblong or lanceolate, (4—)7—9(—14) by (1½—)3—4(—6½) cm, coriaceous; base more or less broadly cuneate, often slightly oblique, decurrent; margin entire; apex shortly, broadly, and bluntly acuminate to blunt or rounded; midrib not infrequently splitting up into 2 or 3 veins near the apex; nerves (6—)8(—12) pairs (angle 50—65°), straight to faintly curved, distinctly interarching near the margin; veins and veinlets usually nearly invisible. *Inflorescences* (♀ unknown) terminal or pseudoterminal, narrowly and laxly thyrsoid, 4—11 cm long, with additional axillary ones, few-flowered, more or less densely tomentose, partial inflorescences mostly subsessile. *Flowers* (♀ unknown) c. 4 mm long, glabrous, the receptacle slightly hollowed. *Calyx* 1 mm. *Stamens* 6, free, inserted on the disk, glabrous. *Disk* partly adnate to the recepacle, the undulated, free margin ½ mm high, fleshy, glabrous. *Pistil* in ♂ flowers strongly reduced, glabrous (also in a possibly ⚥ flower), 3-celled. *Infructescences* rarely more than 8 cm long, usually with 3—4 fruits; calyx not enlarged. *Fruits* globular, faintly 3-angular at the base, 8—9 mm in diam., glabrous; pyrene 3-keeled. *Seed* 1, sterile cells slightly reduced.

Distribution: Coastal regions of Queensland and Northern New South Wales.

QUEENSLAND. Fraser Island: *Petrie 18; White 1218.* — Moreton District: *Bailey & Simmonds s.n.* (type *Bursera australasica* F. M. Bailey).
NEW SOUTH WALES. Clarence District: *De Beuzeville 390-36-11, 36-66.*

Ecology: Rain-forests. *Fl.* March—Nov., *fr.* March—May.

Notes. The identity of this species has long been mysterious, since the only specimens quoted — *J. F. Bailey and J. H. Simmonds s.n.* and *F. M. Bailey s.n.* — are more or less anomalous, the fruits and part of the flowers being 4-merous. In particular, the fruits of *De Beuzeville 390-36-11* clearly show the *Canarium* type. The nearest relationship of this species seems to be with *C. oleiferum* from New Caledonia and *C. muelleri* from Queensland.

The name *C. australasicum* (F. M. Bail.) Leenh. had to be rejected in accordance with Intern. Rules of Nomencl. ed. 1956, art. 64 (2).

71. Canarium muelleri F. M. Bailey, 1890, 106; 1899, 224; 1909, 86; Francis, 1951, 432; Leenhouts, 1955a, 41.

Type: Queensland, Johnstone River, *Bancroft s.n.*, ♂ (BRI).

Tree, 20—30 m high, 30—60 cm diam., with large buttresses. *Branchlets* 4—6 mm thick, sparsely tomentose when young, soon glabrescent, greyish-brown; pith coarse, without vascular strands, but with some resiniferous ducts. *Leaves* 2—3-jugate, glabrous. *Leaflets* elliptic to ovate or lanceolate, 5½—10 by 2—4½ cm, thin-coriaceous to stiff-herbaceous; base oblique, cuneate, faintly decurrent; margin entire; apex rounded to acuminate, acumen short, broad, and blunt; nerves 8—12 pairs (angle 50—70°), straight to faintly curved, distinctly interarching at some distance from the margin; veins laxly reticulate, intermediate ones more or less distinctly developed. *Inflorescences* axillary, narrowly thyrsoid, *c.* 10 cm long. *Flowers* (seen only in bud) *c.* 4 mm, glabrous or minutely pubescent. *Calyx* 1—1½ mm. *Stamens* 6, glabrous, in ♀ flowers apparently inserted on the margin of the disk. *Disk* in ♀ flowers adnate to the slightly hollowed receptacle, rim free, thin and fleshy, glabrous; ♂ unknown. *Pistil* densely and shortly tomentose, in ♂ flowers minute. *Infructescences* and *fruits* still unknown.

Distribution: Australia (Queensland).

QUEENSLAND. *F. M. Bailey s.n.; Bancroft s.n.; Francis s.n.; Fraser s.n.; Gleghorn s.n.; Unknown coll. 47.*

Uses: The timber is recommended for cabinet-making, plywood, and lining. For the composition of the resin see Jones & Smith, Proc. R. Soc. Queensl. 37, 1926, 92.

Note. Taxonomy. Closely related to *C. baileyanum;* mainly different from the latter in the following characters: conspicuous intermediate veins; leaves almost as constantly 3-jugate as they are 1-jugate in *C. baileyanum;* petioles flattened above (cylindrical in *C. baileyanum*); leaflets thinner, greyish-green when dry (olive brown in *C. baileyanum*); number of secondary nerves slightly larger.

72. Canarium oleiferum Baillon, 1871—1872, 341; Engler, 1883, 135, t. 3 f. 23; Leenhouts, 1955a, 41, f. 18. — *Canariellum oleiferum* Engler, 1896, 242, f. 137; 1931, 450, f. 214; Guillaumin, 1909a, 250, f. 31; 1911d, 114; Mezger, 1926, 8, t. 8; Däniker, 1932, 205; Guillaumin, 1938, 21; 1941, 323; 1948b, 170.

Type: New Caledonia, Drobio, Febr. 1872, *Balansa 3458*, ♂ and fr., lectotype (P).

Tree, *c.* 20 m high. *Branchlets* 4—7 mm thick, young parts ferruginously tomentose, older ones covered by the reticular remainder of the tomentose epiderm; pith without vascular strands. *Leaves* unifoliolate (to 2-jugate), the petioles densely ferruginously (later greyish-brown) tomentose. *Leaflets* elliptic (to oblong-ovate), 5—13½(—17) by 3½—7½(—9½) cm, coriaceous, shortly ferruginously tomentose, mainly on the nerves, to greyishly papillose beneath; base broadly cuneate (to rounded), decurrent; margin entire; apex broadly rounded to emarginate or shortly and bluntly acuminate; midrib more or less distinctly bifurcate towards the apex if the latter is not acuminate; nerves 4—8 pairs (angle 55—65°), faintly

S-shaped to straight, more or less distinctly arching near the margin. *Inflorescences* terminal, 15—20 (♀ up to 25) cm long, branches up to 8 cm, ferruginously tomentose, ♂ flowers clustered; in the lower part of the inflorescences a few unifoliolate, small (apical ones 1 by ½ cm, petioles 1 cm long) leaves. *Flowers* ♂ 5—6 mm long, ♀ 6—7 mm. *Calyx* 2—3 mm. *Corolla* outside densely shortly tomentose. *Stamens* 6, free, glabrous. *Disk* cupular, margin undulate to truncate, ½—1 mm high, fleshy, glabrous, specially in ♂ flowers rather variable. *Pistil* in ♂ flowers slightly to totally reduced, in ♀ flowers densely shortly ferruginously tomentose, 2(—3)-celled. *Infructescences* unknown. *Fruits* subovoid, 5 by 3½ cm, glabrous; pericarp hard, lacunar; pyrene smooth, faintly 2-ribbed; lids 4 mm thick, axial intrusion not clearly distinguishable. *Seed* 1, the sterile cell more or less reduced.

Distribution: New Caledonia.

NEW CALEDONIA. *d'Alleizette in herb. L 951.54—150; Balansa 481* (paratype), *3011, 3458* (lectotype); *Bierrou 7; Cribs 1549; Franc s.n. (herb. Bonati 241), Franc 1595 A, 1918; Pancher 19; Le Rat 212, 442, 742, 1082, 2985; Vieillard 4* (paratype), *692*.

Ecology: Forests at low and medium altitudes. *Fl.* Dec.—Febr., *fr.* Febr.

Uses. The oily seeds are eaten.

Note. Engler (1896, 242) based his genus *Canariellum* mainly on the two-celled fruits, the unifoliolate leaves, and the absence of vascular bundles in the medulla of the branchlets. None of these three characteristics is completely differential, as each is found occasionally in other *Canarium* species, especially New Caledonian ones, whose insertion in the genus is beyond doubt. Among these, *C. baileyanum* is most closely related to *C. oleiferum*.

73. Canarium trifoliolatum Engler, 1883, 124; Guillaumin, 1911d, 114; 1948b, 171; Leenhouts, 1955a, 49, f. 21.

Type: New Caledonia, Mt Pénari, alt. 200 m, Febr. 1872, *Balansa 3550*, ♂ (P; isotype in L).

Small tree, 6—8 m high. *Branchlets* 7 mm thick, youngest parts densely shortly greyish brown tomentose, glabrescent; pith without vascular strands. *Leaves* trifoliolate (to 2-jugate), fulvously tomentose when young, glabrescent. *Leaflets* ovate, 8—10½ by 5—6 cm, coriaceous; base, especially in older leaves, very oblique, rounded; margin entire; apex tapering acuminate, acumen *c.* 1 cm long, blunt; nerves 8—9 pairs (not infrequently one nerve more at one side of the leaflet then at the other) (angle 70—80°), bifurcating near the margin and arching with intermediate veins. *Inflorescences* (♀ unknown) axillary, branched, 7 cm long, shortly and thinly greyish tomentose, branches up to 1 cm long. *Flowers* (♀ unknown) *c.* 2 mm long, with a slightly hollowed receptacle. *Calyx* 1½ mm, minutely puberulous. *Stamens* 6, free, glabrous. *Disk* cupular with irregularly undulated margin ¼ mm high, fleshy, glabrous. *Pistil* not strongly reduced, glabrous. *Infructescences* and *fruits* unknown.

Distribution: New Caledonia.

NEW CALEDONIA. *Balansa 3550* (type).

Ecology: Alt. 200 m. *Fl.* Febr.

74. Canarium balansae Engler, 1883, 117; Guillaumin, 1909a, 222—224, f. 10, 22[18], 23 [8,9]; 1911d, 114; 1943, 218; 1948b, 171; Leenhouts, 1955a, 48, f. 20.

Type: Loyalty Islands, Lifu, Chépénéhé, July 1869, *Balansa 2324,* young fl. & fr., lectotype (P; isotypes in K, L).

Tree, 15—20 m high. *Branchlets* ½ cm thick, thinly, shortly, and fulvously puberulent; pith with a peripheral cylinder of amphivasal vascular strands with large resiniferous ducts, central part with some scattered conspicuous large parenchymatic cells. *Leaves* whorled in threes, 2—3-jugate (some unifoliolate ones near the inflorescences), fulvously tomentose when young, glabrescent. *Leaflets* elliptic (basal ones ovate), usually slightly oblique, 7—14 by 4½—7 cm, (basal ones 5½ by 3½—4 cm, unifoliolate ones near the inflorescences 4 by 2 cm), coriaceous; base oblique, (rounded to) subcordate; margin entire; apex gradually acuminate, acumen short, broad, and blunt; nerves 7—9(—12) pairs (angle from base to apex 60—50°), straight to slightly (near the margin strongly) curved, not distinctly arching. *Inflorescences* (♀ unknown) axillary, much branched, probably not very large, glabrous. *Flowers* (♀ unknown) glabrous, the receptacle slightly hollowed, the buds globose, 1½ mm in diam. *Stamens* 6. *Disk* partly adnate to the receptacle. *Pistil* strongly reduced, glabrous. *Infructescences* axillary, up to 9 cm long, with 1—3 fruits; calyx faintly 3-lobed, 3 mm in diam. *Fruits* compressed elliptical, acute at apex, acuminate at base, 2½—3½ by 1¾—2 by 1.2—1.6 cm, glabrous; pyrene somewhat gibbous; lids 1 mm thick; 1 or 2 cells well-developed and fertile, the third one strongly to entirely reduced. *Cotyledons* dark green, herbaceous.

Distribution: Loyalty Islands.

LOYALTY ISLANDS. *Balansa 2324* (lectotype); *Deplanche 55* (paratype).

75. Canarium whitei Guillaumin, 1926, 91; 1948b, 171; Leenhouts, 1955a, 41, f. 17.

Type: New Caledonia, Rio des Pirogues, Oct. 27, 1923, *White 2255,* fr. (P; isotypes in A, BRI, L).

Medium-sized tree. *Branchlets* angular, c. 1 cm thick, brown tomentose, glabrescent; pith with scattered small sclerenchymatic strands without resiniferous ducts. *Leaves* 5—8-jugate, brown tomentose when young, glabrescent. *Leaflets* oblong to (basal and terminal ones) elliptic, 6—14 by 2½—4 cm, coriaceous; base cuneate, decurrent; margin entire; apex abruptly acuminate, acumen long (6—9 mm), narrow, and blunt; nerves from 8—9 in basal to 11—13 pairs in terminal leaflets (angle from base to apex 50—90°), gradually curved, arching at some distance from the margin. *Inflorescences* and *flowers* unknown. *Infructescences* axillary, racemose, probably short and with only a few fruits; calyx 3-lobed, 1½ cm in diam., glabrous without, inside shortly fulvous-tomentose, remainder of disk annular, reddish-brown pilose. *Fruits* obovoid, slightly compressed, 4¾ by 3.4 by 2½ cm, glabrous; pyrene smooth; lids 4 mm thick; 2 cells, one slightly reduced.

Distribution: New Caledonia.

NEW CALEDONIA. *White 2255* (type).

Ecology: Rain forest. *Fr.* Oct.

Note. As has been remarked by Guillaumin, this species is related to *C. balansae.* There is a striking resemblance in the shape of the fruit, which has been found in no other species.

DOUBTFUL SPECIES

Canarium decipiens H. J. Lam, 1932a, 209; 1932b, 447, t. 9 f. 56.

The type specimen of this species (*unknown coll. 296* in BO) is very poor and the locality is unknown. In my opinion it is possibly related to or even conspecific with *C. fusco-calycinum* Stapf.

Canarium engleri H. J. Lam, 1932a, 208; Leenhouts, 1956, 279. — *Pimela oleosa* Loureiro, 1790, 408; 1793, 496; Blume, 1850, 221; Merrill, 1935, 227. — *C. oleosum* (*non* Engl.) Guillaumin, 1911c, 710.

According to Loureiro's description this species probably belongs to a quite different genus or even to a different family. I was not able to identify it with any of the Indo-Chinese species known to me.

Canarium mansfeldianum Engler, 1910, 137; 1915, 782.

This species is based upon the specimen *Mansfeld 27* from Ossidje or Ossidinge, Cameroons. I did not see the type specimen or any other bearing this name. According to the description it can hardly be synonymous to *C. schweinfurthii*, but, as only sterile material was known, and as nothing is said about the stipules, it might very well belong to the genus *Dacryodes (Pachylobus)*. Possibly the vernacular name *edjum* will be of some value for the definite interpretation.

EXCLUDED SPECIES

Canarium aneityense Guillaumin, 1933, 54 = *Haplolobus floribundus* (K. Sch.) H. J. Lam.

Canarium angulatum Ridley, 1931, 493 = *Dacryodes incurvata* (Engl.) H. J. Lam.

Canarium angustifolium (Bl.) Miquel, 1869, 117; Lam, 1932b, 479, t. 11 f. 71d, *sub C. rigidum* Zippelius. — *Pimela angustifolia Blume,* 1850, 226. — *Canariopsis angustifolia* Miquel, 1859, 653 = *Meliosma sp. (Sabiac.).*

Canarium articulatum Engler *ex* Koorders, 1903, 97, *nom. nud.* = *Dacryodes rostrata* (Bl.) H. J. Lam.

Canarium brunneum Beddome, 1869, t. 127 = *Scutinanthe brunnea* Thwaites.

Canarium buettneri Engler, 1892, 101 = *Dacryodes buettneri* (Engl.) H. J. Lam.

Canarium caudatifolium Merrill, 1915c, 315 = *Dacryodes rostrata* (Bl.) H. J. Lam.

Canarium connarifolium Perkins, 1904, 92 = *Protium connarifolium* (Perk.) Merrill.

Canarium costatum (Benn.) Ridley, 1930, 82 = *Dacryodes costata* (Benn.) H. J. Lam.

Canarium crassifolium Merrill, 1915b, 274 = *Dacryodes rostrata* (Bl.) H. J. Lam.

Canarium cuspidatum (Bl.) Merrill, 1921, 316 = *Dacryodes rostrata* (Bl.) H. J. Lam.

Canarium edule (G. Don) Hooker f., 1849, 285 = *Dacryodes edulis* (G. Don) H. J. Lam.

Canarium eupteron Miquel, 1859, 648 = *Santiria oblongifolia* Blume.

Canarium expansum Ridley, 1930, 83 = *Dacryodes expansa* (Ridl.) H. J. Lam.

Canarium fragile Engler, 1883, 138 = *Dacryodes laxa* (Benn.) H. J. Lam.

Canarium furfuraceum Lauterbach, 1920, 325 = *Haplolobus floribundus* (K. Sch.) H. J. Lam.

Canarium gilvescens Miquel, 1859, 650, *nom. illeg.* = *Dacryodes rostrata* (Bl.) H. J. Lam.

Canarium hirtipetalum Ridley, 1930, 84 = *Santiria mollis* Engler.

Canarium incurvatum Engler, 1883, 138 = *Dacryodes incurvata* (Engl.) H. J. Lam.

Canarium kadondon A. W. Bennett, 1875a, 535 = *Dacryodes rostrata* (Bl.) H. J. Lam.

Canarium korthalsii Miquel, 1859, 645 = *Santiria tomentosa* Blume.

Canarium laevigatum (Bl.) Miquel, 1859, 648 = *Santiria laevigata* Blume.

Canarium laxum A. W. Bennett, 1875a, 535 = *Dacryodes laxa* (Benn.) H. J. Lam.

Canarium macrophyllum Oliver, 1868, 327 = *Dacryodes macrophylla* (Oliv.) H. J. Lam.

Canarium mahassan Miquel, 1861, 526 = *Triomma malaccensis* Hooker *f.*

Canarium micrantherum Stapf *ex* Ridley, 1930, 82 = *Santiria tomentosa* Blume.

Canarium minahassae Koorders, [1898, 376, *nom. nud.*] 1903, 96, *descr.* = *Dacryodes rostrata* (Bl.) H. J. Lam.

Canarium montanum (Bl.) Korthals *ex* Miquel, 1859, 649 = *Dacryodes rostrata* (Bl.) H. J. Lam.

Canarium moultonii Ridley, 1930, 83 = *Dacryodes rugosa* (Bl.) H. J. Lam.

Canarium mubafo Ficalho, 1881, 611 = *Dacryodes edulis* (G. Don) H. J. Lam.

Canarium nitens Merrill, 1915a, 24 = *Dacryodes incurvata* (Engl.) H. J. Lam.

Canarium oblongifolium Miquel, 1859, 645 = *Santiria oblongifolia* Blume.

Canarium pachypodum Lauterbach, 1920, 324 = *Haplolobus acuminatus* (K. Sch.) H. J. Lam.

Canarium parciflorum Ridley, 1930, 80 = *Santiria apiculata* Bennett.

Canarium planchoni (Benn.) King, 1894b, 240 = *Santiria rubiginosa* Blume.

Canarium reticulatum Ridley, 1930, 83, *nom. illeg.* = *Dacryodes rostrata* (Bl.) H. J. Lam.

Canarium rostriferum Miquel, 1861, 526 = *Dacryodes rostrata* (Bl.) H. J. Lam.

Canarium rubiginosum A. W. Bennett, 1875a, 535 = *Dacryodes rubiginosa* (Benn.) H. J. Lam.

Canarium rubiginosum (Bl.) Miquel, 1859, 651 = *Santiria rubiginosa* Blume.

Canarium rufescens (Bl.) Miquel, 1859, 650 = *Santiria laevigata* Blume.

Canarium rugosum (Bl.) Miquel, 1859, 649 = *Dacryodes rugosa* (Bl.) H. J. Lam.

Canarium saphu Engler, 1893, 99, t. 3 = *Dacryodes edulis* (G. Don) H. J. Lam.

Canarium virgatum (Bl.) Miquel, 1859, 650 = *Dacryodes rugosa* (Bl.) H. J. Lam.

Canarium vrieseo-teysmannii H. J. Lam, 1932a, 216 = *? Aphanamixis sp. (Meliac.).*

Canariopsis angustifolia (Bl.) Miquel, 1859, 653, see *Canarium angustifolium* (Bl.) Miquel.

Pimela angustifolia Blume, 1850, 226, see *Canarium angustifolium* (Bl.) Miquel.

Pimela caryophyllacea Blume, 1850, 222; Merrill, 1917, 305. — *Canarium tengio cana* Rumphius, 1741, 154.

The identity of this species is not clear to me, but in my opinion it does not belong to the genus *Canarium.*

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— *amboinense Hochr. (16)*
— *aneityense Guill. (excluded)*
— *angulatum Ridl. (excluded)*
— *angustifolium Miq. (excluded)*
— *antonii Elm. (38)*
— apertum H. J. Lam 31
— *apoense Elm. (61)*
— *appendiculatum Laut. (11)*
— *articulatum Engl. ex Koord. (excluded)*
— asperum Benth. 61
— *auriculatum Winkl. (25)*
— *australasicum Leenh. (70)*
— *australasicum F. v. M. ex Benth. (51)*
— australianum F. v. M. 51
— *bacciferum Leenh. (67)*
— baileyanum Leenh. 70
— balansae Engl. 74
— balsamiferum Willd. 35
Canarium *barnesii Merr. (61)*
— *bataanense Merr. ex Sasaki (54)*
— *beccarii Engl. (20)*
— bengalense Roxb. 46
— *bennettii Engl. (1)*
— *bersamifolium Perk. (54)*
— *boivinii Engl. (27)*
— *branderhorstii Laut. (11)*
— *brunneum Bedd. (excluded)*
— *buettneri Engl. (excluded)*
— *calophyllum Perk. (61)*
— *carapifolium Perk. (18)*
— *caudatifolium Merr. (excluded)*
— caudatum King 5
— *celebicum Engl. ex Koord. (35)*
— cestracion Leenh. 59
— *chevalieri Guill. (28)*
— chinare Grutt. & H. J. Lam 65
— *cinereum Guill. (45)*
— *clementis Merr. (61)*
— *coccineo-bracteatum Kurz (21)*
— *colophonia Baker (26)*
— *commune L. (15, 16)*
— *connarifolium Perk. (excluded)*
— *copaliferum Chev. (42)*
— *costatum Ridl. (excluded)*
— *costulatum Elm. (54)*
— *crassifolium Merr. (excluded)*
— *cumingii Engl. (61)*
— *cuspidatum Merr. (excluded)*
— decipiens H. J. Lam (doubtful)
— decumanum Gaertn. 33
— denticulatum Bl. 21
— dichotomum Miq. 52
— divergens Engl. 6
— *dolichophyllum Merr. (60)*
— *edule Hook. f. (excluded)*
— *ellipsoideum Merr. (54)*
— *elmeri Merr. ex H. J. Lam (21)*
— *emarginatum Engl. ex Koord. (54)*
— *endertii H. J. Lam (52)*
— engleri H. J. Lam (doubtful)
— *englerianum Hochr. (35)*
— *euphlebium Merr. (61)*
— euphyllum Kurz 48
— *eupteron Miq. (excluded)*
— euryphyllum Perk. 37
— *expansum Ridl. (excluded)*

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[1] Synonyms are printed in *italics*; the number between brackets refers to the species to which they are reduced.

Canarium *fissistipulum Miq. (21)*
— *flavum Ridl. (1)*
— *fragile Engl. (excluded)*
— *fulvum Laut. (61)*
— *furfuraceum Laut. (excluded)*
— fusco-calycinum Stapf *ex* Ridl. 53
— *fuscum Engl. (21)*
— *gawadaense Baker (17)*
— *giganteum Engl. (1)*
— *gilvescens Miq. (excluded)*
— *glaucum Bl. (1)*
— gracile Engl. 38
— *grandiflorum Benn. (40)*
— grandifolium H. J. Lam 30
— *grandistipulatum Laut. (16)*
— *greshoffii Koord. (54)*
— *gutur De Mikl.-Macl. (62)*
— *harami Bojer (27)*
— harveyi Seem. 14
— *heterophyllum Merr. (61)*
— hirsutum Willd. 54
— *hirtellum Benn. (40)*
— *hirtipetalum Ridl. (excluded)*
— *hispidum Bl. (54)*
— *incurvatum Engl. (excluded)*
— indicum L. 16
— intermedium H. J. Lam 49
— *juglandifolium Perk. (61)*
— *kadondon Benn. (excluded)*
— kaniense Laut. 17
— karoense H. J. Lam 22
— *kerrii Craib (45)*
— *khiala Chev. (28)*
— kinabaluense Leenh. 7
— kipella Miq. 50
— *kitengo Miq. (50)*
— *koordersianum Engl. ex Hochr. (61)*
— *korthalsii Miq. (excluded)*
— kostermansii Leenh. 39
— *kunstleri King (21)*
— *laciniatum Elm. (21)*
— *laevigatum Miq. (excluded)*
— *lagunense Merr. (61)*
— lamii Leenh. 10
— latistipulatum Ridl. 2
— *laxiflorum Decne (34)*
— *laxum Benn. (excluded)*
— *ledermannii Laut. (58)*
— *leeuwenii H. J. Lam (63)*
— *legitimum Miq. (61)*
— *leytense Elm. (61)*
— *lian H. J. Lam (8)*
— *liebertianum Engl. (27)*
— *lineistipula K. Schum. & Laut. (63)*
— *linguistipulum Leenh. (66)*
— littorale Bl. 1
— *longiflorescens Elm. (54)*
— *longiflorum Zipp. ex Miq. (63)*

Canarium *longissimum Hochr. (35)*
— *lucidum Perk. (61)*
— *luxurians Engl. (61)*
— luzonicum A. Gray 18
— macadamii Leenh. 64
— *macrophyllum Oliv. (excluded)*
— madagascariense Engl. 27
— *mafoa Christ. (14)*
— *mahassan Miq. (excluded)*
— maluense Laut. 8
— manii King 24
— mansfeldianum Engl. (doubtful)
— *mauritianum Bl. (26)*
— megacarpum Leenh. 9
— megalanthum Merr. 23
— *mehenbethene Gaertn. (16)*
— *melioides Elm. (19)*
— merrillii H. J. Lam 41
— *micrantherum Stapf ex Ridl. (excluded)*
— *microcarpum Willd. (34)*
— *microphyllum Merr. (37)*
— *minahassae Koord. (excluded)*
— *minutiflorum Engl. (61)*
— *molle Engl. (61)*
— *moluccanum Bl. (16)*
— *montanum Korth. ex Miq. (excluded)*
— *motleyanum Engl. (40)*
— *moultonii Ridl. (excluded)*
— *mubafo Fic. (excluded)*
— muelleri Bail. 71
— *multifidum H. J. Lam (20)*
— *multiflorum Engl. (27)*
— *multijugum H. J. Lam (54)*
— *multipinnatum Llanos (54)*
— *nervosum Elm. (54)*
— *nigrum Engl. (43)*
— *nigrum Roxb. (63)*
— *nitens Merr. (excluded)*
— *nitidum Benn. (4)*
— *nungi Guill. (16)*
— *oblongifolium Miq. (excluded)*
— *obtusifolium S. Elliot (27)*
— *occidentale Chev. (28)*
— odontophyllum Miq. 20
— *odoriferum hirsutum Rumph. (54)*
— *odoriferum leve Rumph. (35)*
— *ogat Elm. (61)*
— oleiferum Baill. 72
— oleosum Engl. 34
— *oliganthum Merr. (18)*
— ovatum Engl. 19
— *oxygonum Quis. & Merr. (54)*
— *pachyphyllum Perk. (19)*
— *pachypodum Laut. (excluded)*
— *palawanense Elm. (20)*
— *palawense Laut. (54)*
— paniculatum Benth. *ex* Engl. 26
— *papuanum H. J. Lam (61)*
— *parciflorum Ridl. (excluded)*

Canarium *parvifolium Benn. (4)*
— parvum Leenh. 44
— patentinervium Miq. 4
— *pauciflorum Ridl. (5)*
— *paucinervium Merr. (37)*
— *perkinsae Merr. (37)*
— perlisanum Leenh. 3
— piloso-sylvestre Leenh. 12
— pilosum Benn. 40
— *pimela Koen. (43)*
— pimela Leenh. 43
— *planchoni King (excluded)*
— *poeloetimbeo Engl. ex Hochr. (35)*
— *polyanthum Perk. (18)*
— *polyneurum Perk. (61)*
— polyphyllum K. Schum. 58
— *pruinosum Engl. (1)*
— *pseudocommune Hochr. (1)*
— pseudodecumanum Hochr. 32
— pseudopatentinervium H. J. Lam 29
— pseudosumatranum Leenh. 55
— *pulchre-bracteatum Guill. (27)*
— *purpurascens Benn. (1)*
— *purpureum Elm. (37)*
— *quadrangulare H. J. Lam (8)*
— *racemosum Merr. (54)*
— *radlkoferi Perk. (54)*
— *ramosii Merr. (37)*
— *reticulatum Merr. (61)*
— *reticulatum Ridl. (excluded)*
— *reziniferum Brace ex King (47)*
— *riedelianum Engl. (54)*
— rigidum Zipp. *ex* Miq. 57
— *robustum Merr. (54)*
— *rooseboomii Hochr. (35)*
— *rostratum Zipp. ex Miq. (63)*
— *rostriferum Miq. (excluded)*
— *rotundifolium Guill. (45)*
— *rubiginosum Benn. (excluded)*
— *rubiginosum Miq. (excluded)*
— *rufescens Miq. (excluded)*
— *rufum Benn. (1)*
— *rugosum Miq. (excluded)*
— salomonense Burtt 13
— *samarense Merr. (61)*
— samoense Engl. 69
— *sanchezii Merr. (61)*
— *saphu Engl. (excluded)*
— *sapidum Hemsl. (14)*
— schlechteri Laut. 62
— schweinfurthii Engl. 28
— *secundum Benn. (1)*
— *serricuspe Miq. (1)*
— *serrulatum Miq. (1)*
— *shortlandicum Rech. (16)*
— *sibulanense Elm. (60)*
— *sibuyanense Elm. (61)*
— *sikkimense King (47)*
— *simplicifolium Engl. (11)*
Canarium *sinense Cana Rumph. (42)*
— *sinense Tsjacana Rumph. (43)*
— smithii Leenh. 67
— *solo Engl. ex Koord. (61)*
— *spectabile Miq. (21)*
— *stachyanthum Perk. (61)*
— *stenophyllum Merr. (37)*
— strictum Roxb. 47
— *subcordatum Ridl. (54)*
— *subrepandum Miq. (4)*
— *subtruncatum Engl. (16)*
— subulatum Guill. 45
— *subvelutinum Elm. (61)*
— sumatranum Boerl. & Koord. 56
— sylvestre Gaertn. 11
— *sylvestre Willd. (11)*
— *sylvestre alterum Rumph. (11)*
— *tamborae Laut. (61)*
— *tengio cana Rumph. (excluded)*
— *thollonicum Guill. (28)*
— *thorelianum Guill. (45)*
— *thyrsoideum Perk. (61)*
— *todayense Elm. (37)*
— *tomentosum Bl. (1)*
— *tongcalingii Elm. (60)*
— *tonkinense Engl. (42)*
— *treubianum Engl. ex Koord. (61)*
— *triandrum Engl. (18)*
— trifoliolatum Engl. 73
— trigonum H. J. Lam 36
— *unifoliolatum Merr. (61)*
— *urdanetense Elm. (61)*
— *valetonianum Engl. ex Hochr. (61)*
— vanikoroense Leenh. 66
— *velutinum Guill. (28)*
— *venosum Craib (45)*
— *villosiflorum Elm. (60)*
— *villosum Benth. & Hook. f. ex F.-Vill. (61)*
— *virgatum Miq. (excluded)*
— vitiense A. Gray 68
— *vittatistipulatum Guill. (45)*
— vrieseanum Engl. 60
— *vrieseo-teysmannii H. J. Lam (excluded)*
— vulgare Leenh. 15
— *vulgare Rumph. prima et secunda species (16)*
— *vulgare Rumph. tertia et quarta species (15)*
— *warburgianum Perk. (54)*
— *wenzelii Merr. (61)*
— whitei Guill. 75
— *williamsii Rob. (60)*
— *zephyrinum Rumph. (16)*
— zeylanicum Bl. 25
— *zollingeri Engl. (61)*
Colophonia mauritiana DC. (26)
— *zeylanica Paxt. (25)*
Dacryodes scandens Huss. (40)

Dammara nigra Rumph. (63)
— nigra legitima Rumph. (61)
Hearnia balansae DC. (42)
Kaekuriaghaha Herm. (25)
— odorata Burm. (25)
Lipara nigra Lour. ex Gom. (43)
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— altissima Bl. (54)
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— caryophyllacea Bl. (excluded)
— decumana Bl. (33)
— denticulata Bl. (61)
— dichotoma Bl. (52)
— glabra Bl. (35)
Pimela hirsuta Bl. (54)
— hispida Bl. (54)
— kipella Bl. (50)
— kitengo Bl. (50)
— laxiflora Bl. (63)
— legitima Bl. (61)
— luzonica Bl. (18)
— nigra Lour. (43)
— oleosa Lour. (doubtful)
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TRACHYPODACEAE

A CRITICAL REVISION

by

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INTRODUCTION

The present study was started as a revision of the *Trachypodaceae* of the Malaysian region. It proved, however, necessary to include the extra-malaysian species of the Malaysian genera in order to solve the taxonomic problems satisfactorily. I also included the extra-malaysian genera of the family (*Pseudospiridentopsis*, *Duthiella* and *Pseudotrachypus*) in this work, this finally resulted in a complete revision of the family of the *Trachypodaceae* all over the world.

All literature and specimens mentioned in this work have been examined by me, if not, this has been specially indicated.

To locate the collecting localities, The Times Survey Atlas of the World (1920) proved a great help and for Indonesia the Atlas van Tropisch Nederland (Nijhoff, 1938) was used. The same spelling of the names in these works has largely been followed.

The material studied was mainly obtained from the following herbaria:

BM	Department of Botany, British Museum (Natural History), London.
BR	Herbier du Jardin Botanique de l'État, Brussels.
FH	Farlow Library and Herbarium of Cryptogamic Botany, Harvard University, Cambridge, Mass. U. S. A.
FI	Erbario del Instituto Botanico dell'Università, Florence.
GRO	Botanisch Laboratorium der Rijksuniversiteit, Afdeling Plantensystematiek, Groningen.
H	Botanical Museum, Helsinki.

K	Herbarium, Royal Botanic Gardens, Kew, Surrey.
L	Rijksherbarium, Leyden.
PC	Laboratoire de Cryptogamie du Muséum National d'Histoire Naturelle, Paris.
U	Botanisch Museum en Herbarium, Utrecht.
W	Naturhistorisches Museum, Vienna.

I here wish to express my indebtedness to the directors and keepers of these herbaria for their valuable help in placing their specimens at my disposal. Also E. B. Bartram, Dr. A. Noguchi, Dr. R. Potier de la Varde and Prof. Dr. K. Sakurai have greatly obliged me for sending me material from their private herbaria.

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The figures are by the able hand of draughtsman R. Hoeksema.

GENERAL SECTION

Trachypodaceae Fleisch.

Fleischer, Hedwigia 45(1905)63; Brotherus, Nat. Pfl. 1, 3(1906)827 (as the subfamily Trachypodeae of the family of the Neckeraceae); Fleischer, Musci Fl. Buitenzorg 3(1908)727; Brotherus, Nat. Pfl. ed. 2, 11(1925)117; Bartram, Philipp. J. Sc. 68(1939)193.

Very slender to very robust, greenish, yellowish or blackish plants (sometimes the lower parts blackish and yellowish-green at the tips) in dull or somewhat glossy, dense to lax mats. Primary stems creeping with tufts of blackish rhizoids and more or less scale-like lower leaves. Secondary stems from 1 up to 30 cm long, procumbent, ascending or hanging down, densely to remotely, regularly or irregularly, pinnately or bipinnately branched, rarely almost simple or somewhat arborescently branched. Central strand present or wanting, but never well-developed. Occasionally few to numerous, longer or shorter flagelliform, rather laxly foliate branches present. Paraphyllia absent. Leaves up to 9 mm long, appressed to horizontally spreading, rarely strongly recurved when dry, sometimes falcate-second, plane to strongly longitudinally plicate (branch leaves occasionally very hollow and carinate), often crisped near apex, rarely strongly undulate in the upper part, from an ovate or broadly ovate, not to strongly auriculate base gradually to abruptly, short- to very long- and narrowly acuminate, either ending in a hairpoint or not; leaf margin almost entire to very strongly toothed or serrate, sometimes crenulate. Leaves isophyllous or heterophyllous, then the branch leaves mostly smaller, shorter and more gradually acuminate than the stem leaves. Leaf rib single, ending below apex or about midleaf, in the branch leaves sometimes faint or nearly absent. Leaf cells isodiametric to linear (up to 12 times as long as wide), towards base mostly more elongate, on both sides unipapillate over lumen or seriately papillate over lumen or on the cell walls, rarely smooth; border cells either differentiated or not; alar cells mostly few, sometimes hardly developed or numerous and large, quadrate to rectangular, smooth; cell walls rather thin to very incrassate and pitted.

Sporophyte lateral on the secondary stems or branches. Seta from

2 mm up to 5 cm long, smooth to strongly papillose. Capsule erect to inclined or horizontal, globular to oblong-cylindrical, sometimes curved, up to 3 mm long. Lid conical, obliquely rostrate. Peristome double. Exostome teeth 16, lanceolate-subulate, on a low basal membrane, mostly yellowish, with a median line, more or less trabeculate, papillose towards the ends. Endostome teeth 16, on a high or rather low, smooth to strongly papillose basal membrane, in most genera of about the same length or somewhat shorter than the exostome teeth, in *Trachypus* however short and more or less rudimentary. Cilia present or absent. Calyptra cucullate and naked or mitriform with numerous hairs. Spores mostly subglobular, more or less papillose, small to large, up to 45 μ in diameter.

History of the family up to the present paper.

The first description of the *Trachypodaceae* was made by Fleischer, Hedwigia 45(1905)63, with 3 genera: *Trachypus* Reinw. et Hornsch., *Trachypodopsis* Fleisch. and *Diaphanodon* Ren. et Card.

Brotherus, Nat. Pfl. 1, 3(1906)827, regards the present family within the family of the *Neckeraceae* as a subfamily, *viz.* the *Trachypodeae.* Afterwards, Nat. Pfl. ed. 2, 11(1925)117, he follows the conception of Fleischer and regards the taxon as to be a separate family.

The section *Pseudo-Spiridentopsis* Broth. of the genus *Trachypodopsis* was raised to generic rank by Fleischer, Musci Fl. Buitenzorg 3(1908)730, and as a genus was called *Pseudospiridentopsis* (Broth.) Fleisch.

In 1923 Fleischer transfers the genus *Duthiella* Broth. (before mostly grouped within the family of the *Leskeaceae* or *Thuidiaceae*) to the family of the *Trachypodaceae*, Musci Fl. Buitenzorg 4(1923)1495, and in 1940 Potier de la Varde and Thériot add the new genus *Pseudotrachypus* P. Vard. et Thér. to the family, Mem. Soc. Nat. Fel. Poey Cubana 14, 4(1940)357.

Up to the present paper the family of the *Trachypodaceae* consisted consequently of the following 6 genera:

1 **Trachypus** Reinw. et Hornsch.
2 **Trachypodopsis** Fleisch.
3 **Diaphanodon** Ren. et Card.
4 **Pseudospiridentopsis** (Broth.) Fleisch.
5 **Duthiella** Broth.
6 **Pseudotrachypus** P. Vard. et Thér.

Relationships.

Fleischer, Hedwigia 45(1905)63; Fleischer, Musci Fl. Buitenzorg 3 (1908)728; ibid. 4(1923)1495; Reimers, Hedwigia 76(1937)211, 212.

Fleischer says about the relationships of the *Trachypodaceae* (l. c. 1905 and 1908, consequently exclusive of the genus *Duthiella*!) the following: "Diese characteristische Gruppe kann (wie auch z. B. die *Lepyrodonteen* und *Cyrtopodeen*) nicht ohne Zwang bei einer der bestehenden Familien eingereiht werden, auch nicht bei den *Neckeraceen,* wie es bis jetzt üblich war; sie ist vielmehr durch *Trachypodopsis* mit den *Prionodontaceen* verwandt. Die Sporogone sowie der Blattcharacter der typischen *Trachypus*-Arten, (*T. bicolor* etc.) sind ganz eigenartig; durch die in dichten Reihen auf den Zellpfeilern stehenden Papillen haben sie einige Analogieen zu gewissen *Papillarien*, die doch wieder erheblich durch die Sporogone und Tracht abweichen. Die Gattungen dieser Familie repräsentieren zwei verschiedene Entwicklungsreihen; die verwandtschaftlichen Beziehungen gehen einerseits von den *Leucodonten* und *Prionodontaceen* über die Gattung *Trachypodopsis* durch *Diaphanodon* zu den *Leskeaceen*, andererseits fehlen bei *Trachypus* nicht Andeutungen, die es wahrscheinlich machen, dass der Ursprung der Familie auf die *Macromitrieen* zurückzuführen ist."

About the genus *Duthiella* Fleischer remarks (l. c. 1905 and 1908): "Die im Himalaya vorkommende Gattung *Duthiella* Geh. et C. Muell. nähert sich im Blattcharacter sehr den *Trachypodaceen*, doch ist sie habituell durch den sporogontragenden Hauptstengel und durch die geneigte Kapsel, die lange Seta und das Hypnumperistom so abweichend, dass sie besser in die Nähe der *Leskeeen* gestellt wird." Afterwards however (l. c. 1923) Fleischer transfers the genus *Duthiella* to the family of the *Trachypodaceae*: "Die Gattung *Duthiella* aus dem Himalaya und Ostasien ist doch richtiger aus den *Leskeaceen* oder *Thuidiaceen* ganz auszuscheiden und den *Trachypodaceen* anzuschliessen, da sie sich z. B. durch *Duthiella Wallichii* direct an die *Trachypodopsis*-arten anschliesst." Whether the place of the genus *Duthiella* within the family of the *Trachypodaceae* is the right one is difficult to ascertain (*cf.* Reimers, l. c. p. 212 and *Duthiella*, relationships).

The hanging habit and the shape of the auricles of some *Trachypodopsis* species may argue relationships with the family of the *Meteoriaceae*.

Relationships within the family.

See the various genera.

Geographical distribution.

The family has its geographical centre in South-East Asia, with radiations into Australia, Oceania, Central and South Africa and into Central and South America (Plate I, Map 1).

Three of the genera, *viz. Diaphanodon*, *Pseudospiridentopsis* and *Duthiella* are restricted to South-East Asia.

Ecology.

On trees, rocks or growing terrestrial from low up to high altitude.

Key to the genera

1. Leaf cells unipapillate or seriately papillate over lumen, rarely smooth.
    2. Plants robust to very robust; stems simple or remotely, irregularly branched; leaves from a sheathing, auriculate base strongly reflexed, up to 9 mm long; seta up to 3 mm long, smooth; capsule ovoidal, erect
    4. **Pseudospiridentopsis** (Broth.) Fleisch.

2. Plants very slender to robust; stems remotely to densely, irregularly of regularly pinnately or bipinnately branched; leaves up to 7 mm long.
   3. Stem and branch leaves strongly dimorphous; stems densely, more or less regularly pinnately or bipinnately branched.
      4. Leaf cells subisodiametric to elongate (up to 6 times as long as wide); stems mostly bipinnately branched (*D. blandus*) **3. Diaphanodon** Ren. et Card.
      4. Leaf cells linear (up to 12 times as long as wide); stems pinnately branched . . . . **6. Pseudotrachypus** P. Vard. et Thér.
   3. Stem and branch leaves not or faintly dimorphous; stems irregularly pinnately branched.
      5. Plants with capsules.
         6. Seta smooth, up to 5 cm long; capsule curved, oblong-cylindrical; endostome with a high basal membrane; cilia 3 **5. Duthiella** Broth.
         6. Seta papillose, up to 18 mm long; capsule erect, subglobular to ovoidal; endostome with a low or rather well-developed basal membrane; cilia absent.
            7. Seta up to 2 mm long; basal membrane of the endostome rather well-developed; leaves not auriculate **3. Diaphanodon** Ren. et Card.
            7. Seta up to 18 mm long; basal membrane of the endostome low; leaves mostly auriculate . . . . **2. Trachypodopsis** Fleisch.
      5. Plants without ripe capsules.
         8. Leaf cells subisodiametric; leaves not auriculate; leaf margin faintly to moderately serrate.
            9. Leaves rather long-acuminate; leaf border clearly differentiated, mostly recurved (*D. procumbens*) . . **3. Diaphanodon** Ren. et Card.
            9. Leaves mostly rather short-acuminate; leaf border not or faintly differentiated, plane . . . . **5. Duthiella** Broth.
         8. Leaf cells elongate to linear (3—10 times as long as wide); leaves either auriculate or not; leaf margin faintly to strongly serrate.
            10. Leaves not auriculate. rather short- to rather long-acuminate, not or faintly longitudinally plicate.
                11. Leaf cells up to 10 times as long as wide, unipapillate over lumen; cell walls somewhat incrassate (*T. serrulata var. serrulata*) . . . . **2. Trachypodopsis** Fleisch.
                11. Leaf cells up to 6 times as long as wide, unipapillate over lumen or up to 10 times as long as wide, but then the leaf cells seriately papillate over lumen; cell walls rather thin (rarely incrassate: *Duthiella robusta*) . . **5. Duthiella** Broth.
            10. Leaves strongly to faintly auriculate, rather long- to very long-acuminate, faintly to strongly longitudinally plicate.
                12. Leaves faintly auriculate, faintly to moderately longitudinally plicate.
                    13. Leaf cells up to 10 times as long as wide; cell walls somewhat incrassate (*T. serrulata var. serrulata*) **2. Trachypodopsis** Fleisch.
                    13. Leaf cells up to 6 times as long as wide; cell walls rather thin (*D. speciosissima*) . . . **5. Duthiella** Broth.
                12. Leaves strongly to rather strongly auriculate, mostly strongly longitudinally plicate . . . . **2. Trachypodopsis** Fleisch.

1. Leaf cells seriately papillate on the cell walls; seta up to 2.5 cm long, strongly papillose; capsule erect, globular to ovoidal; endostome teeth more or less rudimentary **1. Trachypus** Reinw. et Hornsch.

1. **Trachypus** Reinw. et Hornsch.

Reinwardt et Hornschuch, Nov. Act. Leop. Car. 14, 2 Suppl. (1829) 708; Brotherus, Nat. Pfl. 1, 3(1906)829; Fleischer, Musci Fl. Buitenzorg 3(1908)736; Brotherus, Nat. Pfl. ed. 2, 11(1925)118; Bartram, Philipp. J. Sc. 68(1939)193.

Dioicous; very slender to robust, greenish, brownish or blackish plants (often the whole plant blackish but yellowish-green at tips) in dull, dense to lax mats. Primary stems creeping, with tufts of blackish rhizoids and more or less scale-like lower leaves. Secondary stems from 1 up to 20 cm long, procumbent, ascending or somewhat hanging down, densely to remotely, irregularly or more or less regularly pinnately branched, rarely almost simple. Secondary stems and branches mostly densely foliate all around stem, sometimes more or less laxly, somewhat complanately foliate. Occasionally with few to numerous, longer or shorter flagelliform, rather laxly foliate branches, which break off easily. Central strand absent. Leaves appressed to horizontally spreading when dry, erect spreading to horizontally spreading when moist, rarely strongly recurved when dry, up to 5 mm long, plane to longitudinally plicate, sometimes crisped near apex or strongly undulate in the upper half, from an ovate or broadly ovate, *mostly not auriculate* base gradually or somewhat abruptly, short- to very long- and narrowly acuminate, neither ending in a hyaline hairpoint or not; leaf margin almost entire to moderately serrate in the upper half of the leaf, mostly crenulate. Leaves isophyllous or heterophyllous, then the stem leaves larger and longer acuminate than the branch leaves. Leaf rib single, rather strong and ending above midleaf or rather faint and ending in or below midleaf, branch leaves sometimes without rib. Leaf cells hexagonal to elongate or linear (2—12 times as long as wide), cells towards base mostly more elongate, *border cells mostly not differentiated*; alar cells few, quadrate to rectangular; cell walls *incrassate to very incrassate*, mostly *strongly crenulate by numerous papillae;* basal cells and rarely also the border cells in the upper half of the leaf smooth and more pellucid.

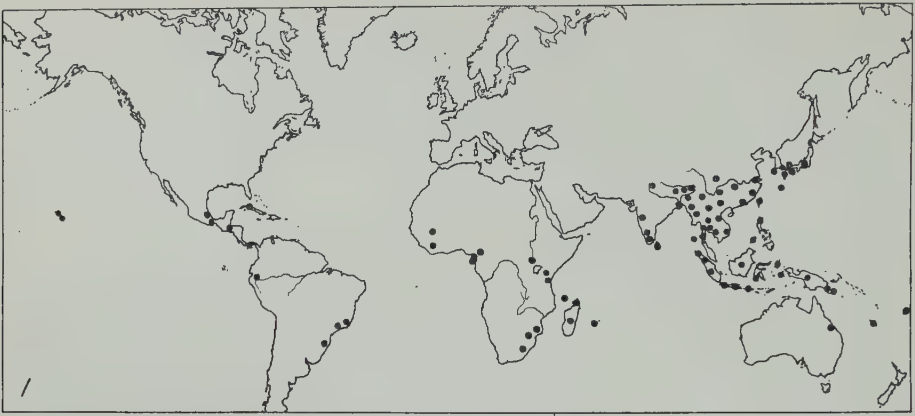
Sporophyte lateral on the secondary stems. Male gametoecia lateral on the secondary stems and branches, bud-shaped; perigamial leaves ovate, hollow, more or less blunt, short-apiculate, without rib; paraphyses few, shorter than the antheridia; antheridia thick, short-stalked. Female gametoecia lateral on the secondary stems, elongate-bud-shaped, large; inner perigamial leaves lanceolate, rather long-acuminate, faintly denticulate in the upper half, rib faint or absent; the outer leaves shorter acuminate; paraphyses rather numerous, of about the same length as the archegonia; archegonia bottle-shaped. Cells of the male and the female perigamial leaves elongate to linear, pellucid or somewhat opaque; cell walls incrassate and more or less crenulate by numerous papillae. Seta *1.5—2.5 cm* long, erect, sometimes somewhat flexuose, *strongly papillose,* reddish-brown or rather pale, contorted when dry. Vaginula cylindrical, smooth, with numerous rather long paraphyses and often with old, stalked archegonia. Perichaetial leaves large, from a sheating base somewhat abruptly or gradually long- and narrowly acuminate; rib faint, ending about midleaf; the outer perichaetial leaves smaller and more abruptly acuminate than the inner ones; aerolation as in the perigamial leaves. *Capsule globular to ovoid, erect,* up to 3 mm long, mostly with a more or less distinct neck, contracted below the mouth when dry, brownish or reddish; exothecium cells roundish to hexagonal or rectangular, in longitudinal rows, mostly somewhat incrassate, smaller towards the mouth, with small stomata near the neck. Lid conical, obliquely and long-rostrate. Peristome double. Exostome teeth 16, lanceolate-subulate, with a median line, more or less trabeculate, papillose, pale-greenish or yellowish. Endostome processes on a rather low, papillose membrane, *more or less rudimentary*, without median line, papillose, much shorter than the exostome teeth; *cilia absent*. Calyptra *mitriform* or cucullate (*T. humilis*, fid. Bartram), with *numerous*, long, yellowish, somewhat nodose *hairs*. Spores medium sized, globular, papillose, about 20—25 μ in diameter, yellowish.

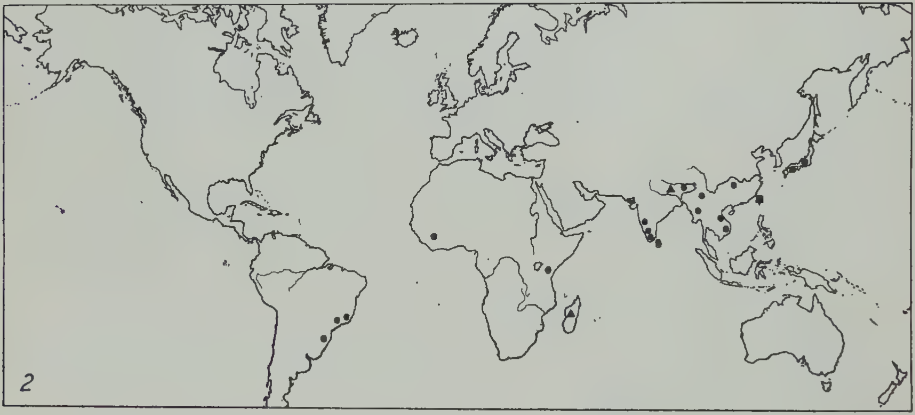
History of the genus up to the present paper.

The first description of the genus *Trachypus* was made by Reinwardt and Hornschuch when they described the new species *T. bicolor* Reinw. et Hornsch. from Java, Nov. Act. Leop. Car. 14, 2 Suppl. (1829)708. The authors did not indicate a family, but the genus was afterwards mostly placed within the family of the *Neckeraceae*. In 1905 Fleischer transferred the genus to the new family of the *Trachypodaceae*, Hedwigia 45(1905)64 and Musci Fl. Buitenzorg 3(1908)727, first described by him. Most authors follow this conception *e. g.* Brotherus in Nat. Pfl. ed. 2, 11(1925)118. Other authors however, among them Dixon, J. of Bot. 53(1915)290, maintain that the taxonomical position of the genus is within the *Neckeraceae*.

The following species and varieties have successively been added to the genus:

T. atratus Mitt. = **Aërobrydium punctulatum** (C. Muell.) Dix.	J. Linn. Soc. Bot. Suppl. 1(1859)129.
T. auriculatus Mitt. = **Trachypodopsis auriculata** (Mitt.) Fleisch.	J. Linn. Soc. Bot. Suppl. 1(1859)129.
T. blandus (Harv.) Mitt. = **Diaphanodon blandus** (Harv.) Ren. et Card.	J. Linn. Soc. Bot. Suppl. 1(1859)127.
T. brevirameus (C. Muell.) Mitt. = **Meteorium brevirameum** (C. Muell.) Broth.	J. Linn. Soc. Bot. Suppl. 1(1859)129.
T. buchanani (Brid.) Mitt. = **Meteorium buchanani** (Brid.) Broth.	J. Linn. Soc. Bot. Suppl. 1(1859)129.
T. cerinus Mitt. = **Papillaria cerina** (Mitt.) Par.	J. Linn. Soc. Bot. 4(1859)91.
T. crispatulus (Hook.) Mitt. = **Trachypodopsis crispatula** (Hook.) Fleisch.	J. Linn. Soc. Bot. Suppl. 1(1859)129.
T. cuspidiferus Mitt. = **Papillaria crocea** (Hamp.) Jaeg.	J. Linn. Soc. Bot. Suppl. 1(1859)128.
T. declinatus Mitt. = **Trachypodopsis declinata** (Mitt.) Fleisch.	J. Linn. Soc. Bot. Suppl. 1(1859)129.





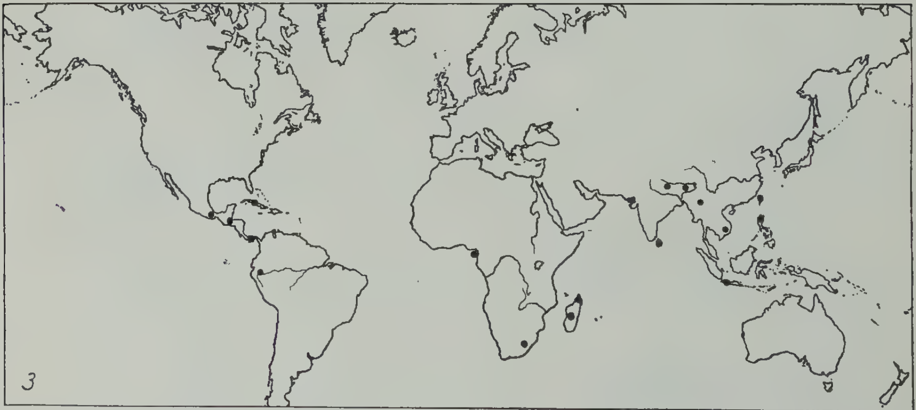


Plate I. — Map 1: Area of the family of the *Trachypodaceae*; Map 2: Area of *Trachypus bicolor* Reinw. et Hornsch. var. *hispidus* (C. Muell.) Card. (●), var. *scindifolius* (Sak.) Nog. (■) and of *Trachypus appendiculatus* (Ren. et Card.) Broth. (▲) (Madagascar and Himalaya, both without definite locality); Map 3: Area of *Trachypus bicolor* Reinw. et Hornsch. var. *viridulus* (Mitt.) Zant.

T. flexicaulis (Tayl.) Mitt. = **Papillaria flexicaulis** (Tayl.) Jaeg.	J. Linn. Soc. Bot. 4(1859)91.
T. fuscescens (Hook.) Mitt. = **Papillaria fuscescens** (Hook.) Jaeg.	J. Linn. Soc. Bot. Suppl. 1(1859)128.
T. harveyi Mitt. (orthogr. orig.: *harveii*) = **Papillaria semi-torta** (C. Muell.) Jaeg.	J. Linn. Soc. Bot. Suppl. 1(1859)128.
T. hornschuchii Mitt. = **Papillaria crocea** (Hamp.) Jaeg.	J. Linn. Soc. Bot. 4(1859)90.
T. plicaefolius (C. Muell.) Mitt. = **Meteorium miquelianum** (C. Muell.) Fleisch.	J. Linn. Soc. Bot. Suppl. 1(1859)129.
T. procumbens (C. Muell.) Mitt. = **Diaphanodon procumbens** (C. Muell.) Ren. et Card.	J. Linn. Soc. Bot. Suppl. 1(1859)127.
T. helictophyllus Mitt. = **Meteorium intricatum** Mitt.	Bonpl. 9(1861)366.
T. blandus (Harv.) Mitt. var. *thuiodes* Bosch. et Lac. = **Diaphanodon javanicus** Ren. et Card. f. **robustior** Ren. et Card.	Bryol. Jav. 2(1864)101.
T. nigrescens (Hedw.) Mitt. = **Papillaria nigrescens** (Hedw.) Jaeg.	J. Linn. Soc. Bot. 8(1864)45.
T. rugosus Lindb. = **Neolindbergia rugosa** (Lindb.) Fleisch.	Oefv. K. Vet. Akad. Foerh. 21, 10(1865)602.
T. humilis Lindb.	Act. Soc. Sc. Fenn. 10(1872)230.
T. nodicaulis (C. Muell.) Besch. (sometimes spelled: *nudicaulis*) = **Trachypodopsis nodicaulis** (C. Muell.) Fleisch.	Ann. Sc. Nat. Bot. 6, 10(1880)270.
T. perichaetiale (Hamp.) Besch. = **Papillaria perichaetialis** (Hamp.) Jaeg.	Ann. Sc. Nat. Bot. 6, 10(1880)270.
T. serrulatus (P. Beauv.) Besch. = **Trachypodopsis serrulata** (P. Beauv.) Fleisch.	Ann. Sc. Nat. Bot. 6, 10(1880)269.
T. rutenbergii C. Muell. = **Trachypodopsis rutenbergii** (C. Muell.) Fleisch.	Abh. Naturw. Ver. Bremen 7, 2(1881)209.
T. baviensis Besch.	J. de Bot. 4(1890)203.
T. massarti Ren. et Card.	Rev. Bryol. 23(1896)103.

T. ornans (Reich.) C. Muell. = **Trachypodopsis ornans** (Reich.) Fleisch.	Fl. 82(1896)465.
T. nietneri (C. Muell.) Par.	Ind. Bryol. (1898)1303.
T. hispidus (C. Muell.) Par. = **Trachypus bicolor** Reinw. et Hornsch. var. **hispidus** (C. Muell.) Card.	Ind. Bryol. (1898)1303.
T. himantophyllus Ren. et Card. = **Trachypodopsis himantophylla** (Ren. et Card.) Fleisch.	Bull. Soc. Roy. Bot. Belg. 38, 1(1900)22.
T. rigidus Broth. et Par. = **Trachypus bicolor** Reinw. et Hornsch. var. **rigidus** (Broth. et Par.) Card.	Bull. Herb. Boiss. 2, 2(1902)926.
T. normandi Broth. et Par. = **Trachypodopsis normandi** (Broth. et Par.) Fleisch.	Rev. Bryol. 29(1902)68.
T. flaccidus Card. = **Duthiella flaccida** (Card.) Broth.	Beih. Bot. Centralbl. 19, 2(1905)117.
T. subbicolor Card.	Beih. Bot. Centralbl. 19, 2(1905)117.
T. bicolor Reinw. et Hornsch. var **rigidus** (Broth. et Par.) Card.	Beih. Bot. Centralbl. 19, 2(1905)116.
T. bicolor Reinw. et Hornsch. var. **hispidus** (C. Muell.) Card.	Beih. Bot. Centralbl. 19, 2(1905)116.
T. viridulus (Mitt.) Broth.	Nat. Pfl. 1, 3(1906)830.
T. appendiculatus (Ren. et Card.) Broth.	Nat. Pfl. 1, 3(1906)829.
T. molleri (C. Muell.) Broth.	Nat. Pfl. 1, 3(1906)830.
T. laetus (Ren. et Card.) Broth.	Nat. Pfl. 1, 3(1906)829.
T. paulensis (Broth.) Broth.	Nat. Pfl. 1, 3(1906)830.
T. sinensis (C. Muell.) Par. = **Trachypus bicolor** Reinw. et Hornsch. var **sinensis** (C. Muell.) Broth.	Ind. Bryol. ed. 2, 5(1906)64.
T. appressus Fleisch.	Musci Fl. Buitenzorg 3(1908)737.
T. bicolor Reinw. et Hornsch. var. **pilifer** Fleisch.	Musci Fl. Buitenzorg 3(1908)741.
T. bicolor Reinw. et Hornsch. var. **tenellus** Fleisch.	Musci Fl. Buitenzorg 3(1908)741.
T. cuspidatus Fleisch.	Musci Fl. Buitenzorg 3(1908)741.
T. cuspidatus Fleisch. var. **brevifolia** Fleisch.	Musci Fl. Buitenzorg 3(1908)743.
T. massarti Ren. et Card. var. **brachyphyllus** Fleisch.	Musci Fl. Buitenzorg 3(1908)745.
T. novae-caledoniae Thér.	Bull. Acad. Int. Géogr. Bot. 20(1910)101.

T. tenerrimus Herz.	Hedwigia 50(1910)135.
T. tenerrimus Herz. var. **flagelliferus** Herz.	Hedwigia 50(1910)136.
T. humilis Lindb. var. **brevifolius** Card.	Bull. Soc. Bot. Genève 3, 2(1911)276.
T. molliculus Broth. et Par.	Rev. Bryol. 38(1911)30.
T. rhacomitrioides Broth.	Sitzungsber. Akad. Wiss. Wien 1, 131(1922)214.
T. subpiliferus Card. ex P. Vard. nom. inval. = **Trachypus bicolor** Reinw. et Hornsch. var. **hispidus** (C. Muell.) Card.	Rev. Bryol. 50(1923)73.
T. bicolor Reinw. et Hornsch. var. **sinensis** (C. Muell.) Broth.	Nat. Pfl. ed. 2, 11(1925)119
T. mauiensis Broth.	Bish. Mus. Bull. 40(1927)20 (erroneously as Trachypodopsis mauiensis Broth.).
T. dimorphus Dix. et P. Vard.	Ann. Crypt. Exot. 1, 1(1928)42.
T. bicolor Reinw. et Hornsch. var. **brevifolius** Broth.	Symb. Sin. 4(1929)76.
T. humilis Lindb. var. **major** Broth.	Symb. Sin. 4(1929)76.
T. pendulus Dix.	J. Bombay Nat. Hist. Soc. 39, 4(1937)780.
T. scindifolius Sak. = **Trachypus cuspidatus** Fleisch. var. **scindifolius** (Sak.) Nog.	Bot. Mag. Tokyo 55(1941)208.
T. obtusus Dix. et Thér. = **Anomodon giraldii** C. Muell.	Rev. Bryol. Lich. 13(1942)13.
T. perplicatus Dix.	Farl. 1, 1(1943)35.
T. bicolor Reinw. et Hornsch. var. **simplicicaulis** Dix.	Bryol. 46(1943)20.
T. longifolius Nog.	J. Hattori Bot. Lab. (= J. Hattori Shokub. Kenk.) 2(1947)55.
T. cuspidatus Fleisch. var. **scindifolius** (Sak.) Nog.	J. Hattori Bot. Lab. (= J. Hattori Shokub. Kenk.) 2(1947)53.
T. humilis Lindb. var. **gracilis** Nog.	J. Hattori Bot. Lab. (= J. Hattori Shokub. Kenk.) 2(1947)55.
T. bicolor Reinw. et Hornsch. var. **floribundarioides** Nog.	J. Hattori Bot. Lab. (= J. Hattori Shokub. Kenk.) 2(1947)53.

The species and varieties printed in italics have again been transferred to other genera or have become a variety of another *Trachypus* species.

Up to the present paper the genus *Trachypus* consisted also of 22 validly published species with 15 varieties.

Type species is *T. bicolor* Reinw. et Hornsch.

Notes.

1. *Trachypus feae* C. Muell. nom. nud., Nuov. Giorn. Bot. Ital. 23, 4(1891)601, has been described and transferred to the genus *Papillaria* as *P. feae* C. Muell. ex Fleisch. by Fleischer, Musci Fl. Buitenzorg 3(1908)761.
2. *Trachypus grossiserratus* C. Muell. nom. nud., Nuov. Giorn. Bot. Ital. 23, 4(1891) 601, has been transferred to the genus *Trismegistia* as *T. grossiserrata* (C. Muell.) Fleisch. nom. nud. by Fleischer, Hedwigia 61(1920)404.
3. *Trachypus eriocladioides* C. Muell. nom. nud. (= *Trachypodopsis eriocladioides* (C. Muell.) Fleisch. nom. nud.; Fleischer, Hedwigia 45(1906)68), has been transferred to the genus *Aërobryopsis* as *A. eriocladioides* (C. Muell.) Fleisch. nom. nud. by Fleischer, Hedwigia 61(1920)404.
4. *Trachypus funiformis* C. Muell. nom. nud. is conspecific with *Papillaria bamforthiae* Broth. ex Dix., fid. Dixon, J. of Bot. 50(1912)148.
5. I have not been able to get any material of *Trachypus maisorensis* Broth. nom. nud., mentioned by Paris, Ind. Bryol. Suppl. (1900)322.

Relationships.

Fleischer, Hedwigia 45(1905)63; Fleischer, Musci Fl. Buitenzorg 3(1908)728.

The genus *Trachypus* is clearly distinguished from most other genera on account of its numerous seriate papillae *on the cell walls.* As far as I know only in some species of the genus *Papillaria, e. g. P. fuscescens* (Hook.) Jaeg. and some allied species, this also occurs. These species differ however on account of their pendulous habit and their strongly auriculate leaf base. Moreover the sporophytes are quite different.

Relationships within the genus.

Fleischer, Musci Fl. Buitenzorg 3(1908)737, 744; Brotherus, Nat. Pfl. ed. 2, 11(1925)119.

The genus was divided into 2 sections by Fleischer (l. c.) with the following key.

1. Plants robust, in lax mats; secondary stems remotely pinnately branched, up to 15 cm long, occasionally hanging down; stem and branch leaves not or slightly differentiated . . . . Section **Eutrachypus** Fleisch.
1. Plants slender, with the habit of *Leskea*, in dense mats; secondary stems densely pinnately branched, procumbent, short, with numerous flagellae; stem and branch leaves rather strongly differentiated . . . . Section **Microtrachypus** Fleisch.

To the section *Eutrachypus* there belonged, according to Fleischer, 4 species: *viz. T. appressus* Fleisch., *T. bicolor* Reinw. et Hornsch., *T. cuspidatus* Fleisch. and *T. nietneri* (C. Muell.)Par. and to the section *Microtrachypus* 2 species: *viz. T. massarti* Ren. et Card. and *T. laetus* (Ren. et Card.)Broth.

Type species of the section *Microtrachypus* was *T. massarti.*

According to Brotherus (l. c.) the following species belonged to the section Microtrachypus:
T. massarti Ren. et Card.
T. novae-caledoniae Thér.

and to the section Eutrachypus:
T. paulensis (Broth.) Broth.
T. viridulus (Mitt.) Broth.

T. tenerrimus Herz.
T. subhumilus Broth. nom. nud.
T. humilis Lindb.
T. laetus (Ren. et Card.) Broth.
T. appendiculatus (Ren. et Card.) Broth.
T. molliculus Broth. et Par.
T. molleri (C. Muell.) Broth.
T. bicolor Reinw. et Hornsch.
T. nietneri (C. Muell.) Par.
T. appressus Fleisch.
T. cuspidatus Fleisch.
T. rhacomitrioides Broth.

Sakurai added *T. scindifolius* Sak. to the secion *Eutrachypus*, Bot. Mag. Tokyo 55(1941)208, and Noguchi *T. longifolius* Nog. to the section *Microtrachypus*, J. Hattori Bot. Lab. (= J. Hattori Shokub. Kenk.) 2(1947)55.

Although the differences between the two sections in general are clear enough it is in my opinion not practical to divide the genus into the two sections, because they more or less gradually pass into each other. There occur for instance plants with the slender habit of section *Microtrachypus*, whereas the stem and branch leaves are hardly differentiated, and medium sized plants with strongly differentiated stem and branch leaves (*cf. T. humilis* Lindb. var. *humilis*, note 1a and 1c).

Note.

According to nomenclatural rules the name *Eutrachypus* is illegitimate and must be replaced by the sectional name *Trachypus*.

Excluded species.

Trachypus baviensis Besch. J. de Bot. 4(1890)203.
= **Chrysocladium spec.**
Trachypus pendulus Dix. J. Bombay Nat. Hist. Soc. 39, 4(1937)780.
= **Papillaria semitorta** (C. Muell.) Jaeg.
Trachypus erosus Besch. nom. nud.
= **Aërobryopsis longissima** (Doz. et Molk.) Fleisch.
Trachypus pilifolius Dix. nom. nud.
= **Floribundaria floribunda** (Doz. et Molk.) Fleisch.

Geographical distribution.

Herzog, Geogr. Moose (1926) 142, 268, 269, 340, 345, 346, 389.

The genus *Trachypus* is distributed over all the tropical regions of the world, but its geographical centre lies in South-East Asia. Only *T. bicolor* Reinw. et Hornsch. (the most variable species of the genus) occurs, besides in South-East Asia, also in the tropical regions of Africa and America. Besides in South-East Asia, *T. humilis* Lindb. is also found in the Hawaiian Islands and *T. appendiculatus* (Ren. et Card.) also in Madagascar.

T. bicolor is a very common species in the mountain forests of South-

East Asia; in tropical Africa and America the species appears to be much less common.

T. humilis is found much less frequently, but may often have been overlooked.

The other *Trachypus* species have been found only once or just a few times.

Ecology.

On trees, sometimes on rocks or growing terrestrial, from low altitudes up to 3300 m.

Key to the species

1. Plants fairly slender to robust; stem and branch leaves not or scarcely differentiated; leaf rib rather strong, ending above midleaf; plants with or without any black colouring.
  2. Leaves strongly undulate in the upper half.
    3. Leaves strongly falcate-second; plants without any black colouring **1d. T. bicolor** Reinw. et Hornsch. var. **scindifolius** (Sak.) Nog.
    3. Leaves not or faintly falcate-second; plants with black colouring **2. T. perplicatus** Dix.
  2. Leaves not or faintly undulate.
    4. Leaves strongly recurved when dry, with small, but distinct auricles; leaf margin in the upper half of the leaf moderately serrate; plants medium sized **3. T. appendiculatus** (Ren. et Card.) Broth.
    4. Leaves not strongly recurved, not or very rarely auriculate; leaf margin entire to faintly denticulate; plants fairly slender to robust **1. T. bicolor** Reinw. et Hornsch.
1. Plants slender to very slender; stem and branch leaves mostly sharply differentiated; leaf rib rather faint, ending in or below midleaf or absent; plants rarely with black colouring.
  5. Leaves very long- and narrowly acuminate; branches attenuate; plants with numerous, long, flagelliform branches . . . . . **5. T. longifolius** Nog.
  5. Leaves longer or shorter, but never very long- and narrowly acuminate; branches often hamate by crowded apical leaves; plants without or with rather few, fairly short flagelliform branches . . . . . **4. T. humilis** Lindb.

1. **Trachypus bicolor** Reinw. et Hornsch.

For literature and type specimens see below.

Dioicous; fairly slender to robust, greenish, brownish or blackish plants (often the whole plant *blackish*, but *yellowish-green at tips*) in dull, rather dense to lax mats. Primary stems creeping, with tufts of blackish rhizoids and more or less scale-like lower leaves. Secondary stems from 2 up to 20 cm long, procumbent, hanging down or somewhat ascending, rather densely pinnately to remotely, irregularly pinnately branched, sometimes almost simple. Central strand absent. Secondary stems and branches mostly densely foliate all around stem, sometimes more or less laxly, somewhat complanately foliate. Often with rather long, flagelliform, mostly laxly foliate branches with small, horizontally spreading leaves without or with a short rib. Leaves appressed to horizontally spreading when dry, erect spreading to horizontally spreading when moist, from *1.5 up to 5 mm* long, sometimes distinctly falcate-second, plane to longitudinally plicate, occasionally crisped near apex, from an ovate or broadly ovate, not or rarely faintly auriculate base gradually or somewhat abruptly longer or shorter acuminate, either ending in a hyaline hairpoint or not; leaf margin *entire to faintly denticulate*, crenulate. Branch leaves often somewhat shorter than the stem leaves and sometimes with a somewhat less distinct hairpoint (if present). Leaf rib single, ending *above midleaf* or towards apex. Leaf cells hexagonal to elongate, 2—8 times as long as wide, more elongate towards base, border cells not differentiated, alar cells few, quadrate to rectangular; cell walls incrassate to strongly incrassate, mostly very strongly crenulate by numerous low, flat papillae; cell walls of the basal cells mostly smooth.

Sporophyte as in the diagnosis of the genus.

This species is a very variable one with 4 varieties which may be distinguished by the following key:

1. Plants fairly slender to medium sized, greenish or brownish, not blackish; stems flaccid, mostly rather laxly foliate; leaves horizontally spreading when dry, up to 3 mm long . . . . **1c.** var. **viridulus** (Mitt.) Zant.
1. Plants fairly slender to robust, mostly blackish below, yellowish-green at tips, occasionally the whole plant brownish-green or green; stems rigid, densely foliate; leaves appressed to horizontally spreading, occasionally distinctly falcate-second when dry, up to 5 mm long.
    2. Plants fairly slender to medium sized; stems rather short, up to 6 cm long; leaves mostly more or less appressed, up to 3 mm long **1b.** var. **hispidus** (C. Muell.) Card.
    2. Plants medium sized to robust; stems up to 20 cm long; leaves appressed to horizontally spreading, occasionally distinctly falcate-second, up to 5 mm long.
        3. Leaves undulate in the upper part, distinctly falcate-second; easily tearing; plants without any black colouring . . **1d.** var. **scindifolius** (Sak.) Nog.
        3. Leaves not or faintly undulate, mostly not falcate second and less easily tearing; plants with or without black colouring . . . **1a.** var. **bicolor**

There occur many plants which are more or less intermediate between these varieties.

1a. **Trachypus bicolor** Reinw. et Hornsch. var. **bicolor.** — Plate II, Fig. 1. Plate III, Map 1.

Trachypus bicolor Reinw. et Hornsch., Nov. Act. Leop. Car. 14, 2, Suppl. (1829)708; Schwaegrichen, Spec. Musc. Suppl. 4(1842) tab. 318; Mitten, J. Linn. Soc. Bot. Suppl. 1(1859)127; van den Bosch and van der Sande Lacoste, Bryol. Jav. 2(1864)98; Geheeb, Rev. Bryol. 21(1894)83; Paris, Ind. Bryol. (1898)1302; Warburg, Monsunia 1(1899)50; Cardot, Rev. Bryol. 28(1901)115; Salmon, J. of Bot. 40(1902)3; Cardot, Beih. Bot. Centralbl. 19, 2(1905)116; Brotherus, Nat. Pfl. 1, 3(1906)830; Paris, Ind. Bryol. ed. 2, 5(1906)63; Fleischer, Musci Fl. Buitenzorg 3(1908)738; Okamura, J. Coll. Sc. Imp. Univ. Tokyo 36(1915)19; Moeller, Hedwigia 60(1919)321; Brotherus, Nat. Pfl. ed. 2, 11(1925)119; Brotherus, Bish. Mus. Bull. 40(1927)20 (erroneously as Trachypodopsis); Brotherus, Symb. Sin. 4(1929)76; Dixon and Greenwood, Proc. Linn. Soc. New S. Wales 55(1930)285; Bruehl, Rec. Bot. Surv. India 13, 1(1931)67; Bartram, Bish. Mus. Bull. 101(1933)162; Sakurai, Bot. Mag. Tokyo 47(1933)335; Dixon, J. Bombay Nat. Hist. Soc. 39(1937)780; Bartram, Philipp. J. Sc. 68(1939)194; Bartram, Farl. 1, 2 (1943)179; Noguchi, J. Hattori Bot. Lab. 5(1951)16; Froehlich, Ann. Naturh. Mus. Wien 59(1953)90; Bartram, Rev. Bryol. Lich. 23(1954)250; Froehlich, Arch. Hydrobiol. Suppl. 21, 3/4(1955)322; Bartram, Britt. 9, 1(1957) 45; Noguchi and Hattori, J. Hattori Bot. Lab. 19(1958)130.

Pilotrichum trachypus C. Muell. nom. illeg.: C. Mueller, Syn. 2 (1851)162.

Neckera trachypus (C. Muell.) C. Muell. nom. illeg.: C. Mueller, Syn. 2(1851)672.

Papillaria bicolor (Reinw. et Hornsch.) Jaeg.: Ber. S. Gall. Naturw. Ges. 1875/76(1877)273 = Ad. 2(1877)177.

Neckera nietneri C. Muell., Linn. 36(1869)25.

Papillaria nietneri (C. Muell.) Jaeg., Ber. S. Gall. Naturw. Ges. 1875/76 (1877)273 = Ad. 2(1877)177.

Trachypus nietneri (C. Muell.) Par. syn. nov.: Paris, Ind. Bryol. (1898) 1303; Brotherus, Nat. Pfl. 1, 3(1906)830; Paris, Ind. Bryol. ed. 2, 5(1906) 64; Fleischer, Musci Fl. Buitenzorg 3(1908)744; Dixon, J. of Bot. 53(1915) 290; Brotherus, Nat. Pfl. ed. 2, 11(1925)119; Bruehl, Rec. Bot. Surv. India 13, 1(1931)67.

Papillaria sinensis C. Muell., Nuov. Giorn. Bot. Ital. 5, 2(1898)191; Fleischer, Musci Fl. Buitenzorg 3(1908)739.

Trachypus sinensis (C. Muell.) Par., Ind. Bryol. ed. 2, 5(1906)64; Cardot, Beih. Bot. Centralbl. 19, 2(1905)116; Brotherus, Nat. Pfl. 1, 3 (1906)829.

Trachypus bicolor Reinw. et Hornsch. var. *sinensis* (C. Muell.) Broth., Nat. Pfl. ed. 2, 11(1925)119; Brotherus, Symb. Sin. 4(1929)76; Sakurai, Bot. Mag. Tokyo 52(1938)131; Noguchi, J. Hattori Bot. Lab. (= J. Hattori Shokub. Kenk.) 2(1947)52; Sakurai, Musc. Jap. (1954)100.

Trachypus appressus Fleisch. syn. nov.: Fleischer, Musci Fl. Buitenzorg 3(1908)737; Brotherus, Nat. Pfl. 1, 3(1909)1228; ibid. ed. 2, 11(1925)119; Bruehl, Rec. Bot. Surv. India 13, 1(1931)67.

Trachypus cuspidatus Fleisch. syn. nov.: Fleischer, Musci Fl. Buitenzorg 3(1908)741; Brotherus, Nat. Pfl. ed. 2, 11(1925)119; Bruehl, Rec. Bot. Surv. India 13, 1(1931)67; Noguchi, J. Hattori Bot. Lab. 5(1951)16; Bartram, Rev. Bryol. Lich. 23(1954)250.

Trachypus bicolor Reinw. et Hornsch. var. *pilifer* Fleisch. syn. nov.: Fleischer, Musci Fl. Buitenzorg 3(1908)741; Potier de la Varde, Rev. Bryol. Lich. 10(1938)141.

Trachypus bicolor Reinw. et Hornsch. var. *tenellus* Fleisch. syn. nov.: Fleischer, Musci Fl. Buitenzorg 3(1908)741; Noguchi, J. Hattori Bot. Lab. (= J. Hattori Shokub. Kenk.) 2(1947)52.

Trachypus bicolor Reinw. et Hornsch. var. *simplicicaulis* Dix. syn. nov.: Dixon, Bryol. 46(1943)20.

Trachypus bicolor Reinw. et Hornsch. var. *floribundarioides* Nog. syn. nov.: Noguchi, J. Hattori Bot. Lab. (= J. Hattori Shokub. Kenk.) 2(1947)53.

Papillaria apophysata C. Muell. nom. nud.: Jaeger, Ber. S. Gall. Naturw. Ges. 1875/76(1877)274 = Ad. 2(1877)178; Paris, Ind. Bryol. (1897)901.

Neckera apophysata (C. Muell.)? nom. nud.

Trachypus apophysata (C. Muell.) Lac. nom. nud.

Brachydon patens Hornsch. nom. nud.: Fleischer, Musci Fl. Buitenzorg 3(1908)738.

Type specimens: *Trachypus bicolor* Reinw. et Hornsch.: Java, leg. Zip(p)elius, 2-1827; neotype in L. — *Trachypus nietneri* (C. Muell.) Par.: Ceylon, leg. ?; type probably lost. — *Trachypus sinensis* (C. Muell.) Par.: China, Shen-si, Mt. Kuan-tou-san, leg. Giraldi, 5-11-1896; lectoisotype in PC. — *Trachypus appressus* Fleisch.: West-Java, Mt. Pangerango, leg. Fleischer, 19-7-1898, No. 374a; lectotypes in L and U. — *Trachypus cuspidatus* Fleisch.: West-Java, Mt. Gedeh, Kandang Badak, leg. Fleischer, 28-3-1902, No. 426; holotype in FH, isotypes in GRO, L and U. — *Trachypus bicolor* Reinw. et Hornsch. var. *pilifer* Fleisch.: Java, Mt. Praoe, Diëngplateau, leg. Fleischer, 22-4-1901; holotype in FH. — *Trachypus bicolor* Reinw. et Hornsch. var. *tenellus* Fleisch.: West-Java, Mt. Gedeh, Tjibeurum, leg. Fleischer; holotype in FH. —*Trachypus bicolor* Reinw. et Hornsch. var. *simplicicaulis* Dix.: West-Java, Mt. Patoeha, leg. Verdoorn, 7-1930, isotype in L. — *Trachypus bicolor* Reinw. et Hornsch. var. *floribundarioides* Nog.: Japan, Honshiu, Mt. Hakone, leg. Bo, 6-1931, No. 4178; isotype in herb. Noguchi.

Medium sized to *robust* plants, mostly *black* or dark brown below, *yellowish-green at tips.* Stems rather densely pinnately to remotely, irregularly pinnately branched or almost simple, mostly *rigid* and *densely foliate*, up to *20 cm* long. Leaves appressed to horizontally spreading when dry, occasionally slightly falcate-second, up to *5 mm* long.

INDONESIA: Java: Mt. Pangerango and Gedeh: leg. Beccari, 1872, No. 14, c.fr. and No. 23 (FI); leg. Beccari, 1875, No. 52 (FI); leg. Docters van Leeuwen, 6-1919, No. 149, c.fr. (GRO, L); leg. Docters van Leeuwen, 9-1921, No. 5585, c.fr. (GRO, L); leg. Docters van Leeuwen, 12-1929, No. 12995, c.fr. (GRO, L); leg. Fleischer, 14-7-1898, No. 45 (GRO, L, U); leg. Fleischer, 19-7-1898, No. 374a (L, U, T. appressus, lectotype); Kandang Badak, leg. Fleischer, No. 1992 (L); Kandang Badak, leg. Fleischer, 28-3-1902, No. 426 (FH, c.fr., T. cuspidatus, holotype; GRO, L, U, isotypes); Tjibodas, leg. Fleischer (FH); Tjibeurum, leg. Fleischer (FH, T. bicolor var. tenellus holotype); leg. van Gesker (L); leg. Kurz, 19-2-1861, No. 437 (L, c.fr. and H); above Tugu, leg. Meyer, 3/4-10-1952, No. B 3394 (GRO, L); Mandalawangi, leg. Meyer, 20-3-1953, No. B 918, c.fr. (GRO, L); Mandalawangi, leg. Meyer, 30-3-1953, No. B 890 (L); Kandang Badak, leg. Meyer, 29-7-1953, No. B 4247, c.fr. (L); leg. Moeller, 26-4-1897, No. 133, c.fr. (H); Kandang Badak, leg. Noerta, 12-5-1949, No. 411 (GRO); Natural Reserve, leg. Noerta, 13-5-1949, No. 495, c.fr. (GRO); Natural Reserve, leg. Noerta, 13-5-1949, No. 467, 488, 547, 567 and 614 (GRO); Natural Reserve, leg. Noerta, 14-5-1949, No. 651 (GRO); Natu, leg. Noerta, 13-5-1949, No. 567 (GRO); leg. van der Sande Lacoste, 1873 (L); above Tjibodas, leg. Schiffner, 24-4-1894, No. 10843 (L); above Tjibeurum, leg. Schiffner, 28-4-1894, No. 10844 (L); above Tjibeurum, leg. Schiffner, 2-5-1894, No. 10860 (L); above Kandang Badak, leg. Schiffner, 4-7-1894, No. 10849 (L); Tjibodas-Tjibeurum, leg. Verdoorn, 6-8-1930, No. 30 (L, c.fr. and GRO); leg. Wichura, 5-12-1861, No. 2439c, c.fr. (H); Kandang Badak, leg. van der Wijk, 19-3-1952, No. 483 and 510 (GRO); above Kandang Badak, leg. van der Wijk, 6-5-1952, No. 1031, 1052 and 1054 (GRO); leg. Zip(p)elius, 2-1827, c.fr. (L, neotype); coll. de Vriese, c.fr. (L); ex herb. van Hall (L); ex herb. Bondam (L). Buitenzorg: leg. Treub, 3-1897 (L); Miquel, c.fr. (L). Rawa Denok: leg. Noerta and Soekar, 8-9-1949, No. 2396 (GRO); Mt. Masigit: leg. Noerta and Soekar, 9-9-1949, No. 2464, 2510 and 2543 (GRO); Mt. Patoeha: leg. Verdoorn, 7-1930, No. 49 (L, U, T. bicolor var. simplicicaulis, isotypes). Mt. Malabar: leg. Pulle, 6-1906, No. 9, c.fr. (U); leg. Verdoorn, 7-1930, No. 61 (GRO, L); leg. Wichura, c.fr. (FH, T. bicolor var. tenellus). Mt. Wayang: leg. Junghuhn, c.fr. (L). Mt. Praoe: Diëngplateau, leg. Fleischer, 22-4-1901, No. 374b (L); Diëngplateau, leg. Fleischer, 22-4-1901 (FH, T. bicolor var. pilifer, holotype); Wonosobo, leg. Fleischer, (FH, T. cuspidatus). Mt. Meraboe: leg. Junghuhn, c.fr. (L). Mt. Lawoe: leg. Verdoorn, 6-1930, No. 40 (GRO, L). Mt. Ardjoeno: leg. Skottsberg, 9-6-1929 (FH). And many specimens from Java without definite locality. — Lombok: Mt. Rindjani: leg. Elbert, 3-5-1909, No. 959 (L); leg. Elbert, 11-5-1909, No. 1294 (L); leg. Elbert, 19-6-1909, No. 2306 (L). — Ceram: leg. de Vriese (L).

— Celebes: Mt. Bonthain, leg. Warburg, c.fr. (FH, H); Bua Kraeng (one of the summits of Mt. Bonthain), leg. Fruhstorfer, 1895 (PC). — Borneo: leg. Korthals, No. 50 (L); leg. Korthals, c.fr. (L). — Sumatra: Mt. Singgalang, leg. Beccari, 7-1878 (L); Mt. Singgalang, leg. Schiffner, 25-7-1894, No. 10852 (L); Mt. Marapi, leg. van der Wijk, 10-6-1952, No. 1464 (GRO); Berastagi, leg. Arens, 20-4-1930, No. 387 (GRO, L); Berastagi, leg. Staal, 23-3-1950, No. 372 (GRO); Padang, leg. Wiltens, 1859 (L).

Philippine Islands: Luzon: Subprov. of Benguet: Mt. Pauai, leg. Merrill, 10/11-1905, No. 4955, c.fr. (H, L); Mt. Pauai, leg. Merrill, 5-1909, No. 6679 (H); leg. Santos, 6-1918, No. 32055 (GRO, L); Distr. of Lepanto: Mt. Data, leg. Merrill, 11-1905, No. 4902, c.fr. (GRO, L); Mt. Data, leg. Merrill, 11-1905, No. 4971, c.fr. (L); Mt. Data, leg. Bacani, 1-1909, For. Bur. No. 16013, c.fr. (H); Mt. Lamunan, leg. Micholitz, 4-1910 (L).

Hawaiian Islands: Maui: leg. Baldwin, 12-1876, No. 170 (H); Mt. Haleakala, leg. Baldwin, 1885, No. 284 (H, T. haleakalae).

Japan: Honshiu: Prov. of Kotsuke: Mt. Akagi, leg. T(s)unoda, 1-4-1910, No. 1344 and 1548 (H); Mt. Myogi, leg. Sakurai, 12-7-1912, No. 504 (H); Prov. of Sagami: Mt. Hiru, leg. Sasaoka, 3-10-1926, No. 2605 (H); Prov. ?, Mt. Hakone, leg. Bo, 6-1931, No. 4178 (herb. Noguchi, T. bicolor var. floribundarioides, isotype). — Kiushiu: Kumamoto, leg. Mayebara, 3-1952, ser. 7 No. 350 (GRO, L).

China: Shen-si: Mt. Kuan-tou-san, leg. Giraldi, 5-11-1896, No. 2271 (PC, T. sinensis, lectoisotype); Mt. Thae-pei-san, leg. Giraldi, 8-9-1897, No. 1654 (H, T. sinensis); leg. Giraldi (FH, T. sinensis, probably one of the last named specimens).

Nepal: near Khatmandu, leg. Rana, 2/3-1900, No. 2165 (H).

India: Sikkim: leg. Kurz, 18-10-1868, No. 2243 (H); Tangloo, leg. Kurz, No. 2096 (H, c.fr. and L, respectively Neckera apophysata and T. apophysatus). — N.W. Himalaya: herb. Falcour (H); Sinchul, leg. Wichura, 19-4-1862, No. 2891b, c.fr. (H). — Himalaya without definite locality: ex herb. Ind. Or. Hook. f. et Thoms., No. 842 (H, L) and No. 845 (L). — Nilgiris: ex herb. Ind. Or. Hook. f. et Thoms., No. 36, c.fr. (L); ex herb. van den Bosch (L). — Madura: Palni Hills: Kodaikanal, leg. Foreau, 1911, No. 37 (PC, T. hispidus); Kodaikanal, leg. Foreau, 1953, No. 63 (GRO).

Ceylon: leg. Boswelt, 1878 (H); Horton Plaines, Pedrotallagalla, leg. Fleischer, 18-2-1898, No. 375 (L, U, T. nietneri); Horton Plaines, Pedrotallagalla, leg. Herzog, 1-1906, No. 72, c.fr. (H, T. bicolor var. hispidus); Horton Plaines, leg. Fleischer, 2-1898, No. 194 (GRO, L, U, T. hispidus); Kirigalpota, leg. Herzog, 2-1906, No. 74a (L); Wattacalla near Kandy, leg. Fleischer, No. 1993 (L, T. bicolor var. hispidus).

Distribution: Ceylon; India (Sikkim, N.W. Himalaya, Assam, Nilgiris, Madura); Nepal; Burma (Chin Hills, Karenni State, Kengtun State, Mang Loen State); Siam; China (Yuennan, Shen-si, Anhwei); Japan; Luzon; Indonesia (Java, Sumatra, Borneo, Celebes, Lombok, Ceram); Australian New Guinea; Fiji Islands; Hawaiian Islands. Common.

Ecology: On trees, sometimes on rocks or terrestrial, from low altitudes up to 3300 m.

Notes. 1. The present variety is a quite variable one. The characters which vary are the following: a) the size, b) the mode of branching, c) the colour, d) the direction of the leaves, e) the shape of the leaves, f) the shape of the leaf cells, g) the colour and the thickness of the seta, h) the shape of the capsule. The structural details of the leaves however are quite uniform.

a) Most plants are robust, but there are also many plants which are more slender. The majority of the plants from Indonesia are more robust than most plants from the other regions. The more slender plants, which therefore incline somewhat towards var. *hispidus* (C. Muell.) Card. also occur in Indonesia, but only rarely and were described by Fleischer as *T. bicolor* var. *tenellus* Fleisch. (l. c. 1908).

b) The plants are mostly irregularly pinnately branched, but may vary from almost simple (var. *simplicicaulis* Dix.) to rather densely pinnately branched.

c) Most plants of this variety are blackish or dark brown below and yellowish-green at tips, but there occur, all over its area many plants which are entirely green or brownish-green. Sometimes these plants are at the same time less robust and vary therefore towards var. *viridulus* (Mitt.) Zant. The colour of the leaves is not a very important character, for there often occur plants which are mainly green or brownish-green, but which have a few branches or only a number of leaves which are black.

d) The leaves are mostly spreading to horizontally spreading when dry, but there occasionally occur plants with appressed leaves, *e. g.* the specimen described by Fleischer as *T. appressus* Fleisch. (l. c. 1908). Fleischer himself says of this species: "Von *T. bicolor*, dem *T. appressus* sehr nahe steht, durch gedrungeneren Habitus und lebhaft gelbe Astspitzen sowie weichere, anliegende Blätter verschieden, welche aus schmälerem, fast ovalem Grunde zugespitzt sind." These characters are however by no means stable ones and fit *T. bicolor* var. *bicolor* equally well as *T. appressus*. The yellowish branch tips for instance are characteristic for var. *bicolor* too (hence the name *bicolor*). The main difference with the majority of var. *bicolor* are the more appressed leaves; this character is mostly not concomitant with the other differences mentioned by Fleischer. The specimens from Ceylon for instance, identified as *T. nietneri* (C. Muell.) Par., have also got rather a narrow leaf base, but horizontally spreading leaves as contrasted with *T. appressus*.

Many plants from the Philippine Islands and Japan are characterized in having more or less appressed, somewhat longer acuminate stem leaves, but the plants are less robust than the type of *T. appressus*.

e) The shape of the leaves is very variable. The leaf base is mostly broadly ovate, but there also occur plants with a narrowly ovate leaf base (*cf.* d). The stem leaves are often somewhat abruptly, rather long-acuminate and pass gradually into the branch leaves, which are mostly somewhat shorter and more gradually acuminate. Very often however the slight difference between the stem and the branch leaves is hardly visible. The leaf apex sometimes ends in a longer or shorter hyaline hairpoint. This for instance is the case in all Philippine plants, which fact was remarked on by Bartram where he writes (l. c. 1939): "The Philippine plants have finely attenuated, almost hairlike points, often hyaline at the tips." But this occurs just as well in many plants from Indonesia, Ceylon and the South-East Asian continent. Fleischer described those plants as the new variety *T. bicolor* var. *pilifer* Fleisch. (l. c. 1908).

f) The structural details of the leaves are quite uniform, only the length of the leaf cells vary from 2—8 times as long as wide (often also on the same plant).

g) and h) The seta is mostly rather thick and brownish-red, but sometimes more or less pale and thinner. The capsule is mostly shortly ovoid with a short neck, sometimes however somewhat more elongate and without a distinct neck. The variation in the seta and in the capsule are independent of each other.

The variability was remarked on by Fleischer where he writes (l. c. 1908): "Diese Art ist in Grösse und Habitus ziemlich veränderlich; ausserdem sind auch die Blätter sehr variabel, wie meistens bei allen weit verbreiteten und massenhaft auftretenden Arten", and Bartram writes (l. c. 1939): "The Philippine plants vary toward *T. cuspidatus* Fleisch. in the leaves which have finely attenuated, almost hairlike points, often hyaline at the tips. I feel that it is more practical to group the local forms under *T. bicolor,* in a broad sense. The varietal forms and some of the allied species are too subtile for my understanding."

2. There occur many intermediate forms between var. *bicolor,* var. *hispidus* (C. Muell.) Card. and var. *viridulus* (Mitt.) Zant. I incorporated all these intermediates in the variety *bicolor* for practical reasons.

3. The similarity between *T. bicolor* and *T. sinensis* (C. Muell.) Par. was remarked on by Cardot where he writes (l. c. 1905): "...... *T. sinensis,* du Schen-Si, qui, d'après les échantillons originaux ne diffère pas du *T. bicolor.*" Later authors (Brotherus, 1925 and 1929; Sakurai, 1938 and 1954; Noguchi, 1947) however considered this species to be the variety *sinensis* (C. Muell.) Broth. of *T. bicolor.*

4. Fleischer describes a new species *T. cuspidatus* Fleisch. (l. c. 1908) saying: "Unsere Art unterscheidet sich von dem in der Blattform sehr ähnlichen *T. bicolor* ausser durch eine Summe kleiner Merkmale, besonders durch etwas sparrigen Habitus." This "Summe kleiner Merkmale" (= a number of little characters) consists, according to the diagnosis, of: a) plants not blackish, b) leaves mostly horizontally spreading, crisped when dry, c) perichaetial leaves shorter acuminate, d) papillae on the seta shorter, e) capsule slightly more elongate and with a indistinct neck.

The differences mentioned under a) and b) are in general correct, but are of little importance (*cf.* note 1c and 1d), moreover they are not always concomitant with the differences mentioned under c), d) and e). In my opinion it is more practical to group the plants identified as *T. cuspidatus* Fleisch. under *T. bicolor* (except for *T. cuspidatus* var. *brevifolia* Fleisch., which plant belongs to var. *viridulus* (Mitt.) Zant.).

5. Somewhat less robust plants with less densely foliate stems and branches and with horizontally spreading leaves from Japan were described by Noguchi as *T. bicolor* var. *floribundarioides* Nog. (l. c. 1947).

1b. **Trachypus bicolor** Reinw. et Hornsch. var. **hispidus** (C. Muell.) Card. — Plate I, Map 2.

Trachypus bicolor Reinw. et Hornsch. var. *hispidus* (C. Muell.) Card., Beih. Bot. Centralbl. 19, 2(1905)116; Fleischer, Musci Fl. Buitenzorg 3(1908)740; Herzog, Hedwigia 50(1910)135; Dixon, J. of Bot. 53(1915)290; Brotherus, Nat. Pfl. ed. 2, 11(1925)119; Foreau, J. Madras Univ. ? (about 1931) ?; Noguchi, J. Hattori Bot. Lab. (= J. Hattori Shokub. Kenk.) 2(1947) 53; Sakurai, Musc. Jap. (1954)100.

Neckera hispida C. Muell., Bot. Zeit. 12, 33(1854)570; C. Mueller, Linn. 36(1869)24.

Meteorium hispidum (C. Muell.) Mitt., J. Linn. Soc. Bot. Suppl. 1 (1859)89.

Papillaria hispida (C. Muell.) Jaeg., Ber. S. Gall. Naturw. Ges. 1875/76 (1877)273 = Ad. 2(1877)177.

Trachypus hispidus (C. Muell.) Par., Ind. Bryol. (1898)1303; Cardot, Beih. Bot. Centralbl. 19, 2(1905)116; Brotherus, Nat. Pfl. 1, 3(1906)830; Williams, Bull. New York Bot. Gard. 8, 31(1914)357; Potier de la Varde, Rev. Bryol. 50(1923)73; Brotherus, Philipp. J. Sc. 31, 3(1926)288; Reimers and Sakurai, Bot. Jahrb. 64(1932)543.

Trachypus rigidus Broth. et Par., Bull. Herb. Boiss. 2, 2(1902)926; Brotherus, Nat. Pfl. 1, 3(1906)829.

Trachypus bicolor Reinw. et Hornsch. var. *rigidus* (Broth. et Par.) Card., Beih. Bot. Centralbl. 19, 2(1905)116; Brotherus, Nat. Pfl. 2, 11 (1925)119; Noguchi, J. Hattori Bot. Lab. (= J. Hattori Shokub. Kenk.) 2 (1947)52; Sakurai, Musc. Jap. (1954)100.

Papillaria paulensis Broth., Bih. K. Svensk. Vet. Akad. Handl. 21, 3, 3(1895)49; Paris, Ind. Bryol. (1897)907; ibid. ed. 2, 3(1905)358.

Trachypus paulensis (Broth.) Broth. syn. nov.: Brotherus, Nat. Pfl. 1, 3(1906)830; ibid. ed. 2, 11(1925)119; Brotherus, Denkschr. Akad. Wiss. Wien 83(1926)316.

Trachypus molliculus Broth. et Par. syn. nov.: Brotherus and Paris, Rev. Bryol. 38(1911)30; Brotherus, Nat. Pfl. ed. 2, 11(1925)119.

Trachypus rhacomitrioides Broth. syn. nov.: Brotherus, Sitzungsber. Akad. Wiss. Wien 1, 131(1922)214; Brotherus, Nat. Pfl. ed. 2, 11(1925)119; Brotherus, Symb. Sin. 4(1929)76.

Trachypus bicolor Reinw. et Hornsch. var. *brevifolius* Broth. syn. nov.: Brotherus, Symb. Sin. 4(1929)76.

Trachypus subpiliferus Card. ex P. Vard. nom. inval.: Potier de la Varde, Rev. Bryol. 50(1923)73.

Trachypus annamensis Broth. nom. nud.: Naveau, Rev. Bryol. n. ser. 1(1928)40.

Trachypus decolyi Broth. nom. nud.: Bruehl, Rec. Bot. Surv. India 13, 1(1931)127.

Trachypus micro-bicolor Broth. nom. nud.

Papillaria nana C. Muell. nom. nud.

Trachypus pterigonocaulos C. Muell. nom. nud.

Trachypus usambaricus Broth. nom. nud.

Trachypus hispidus (C. Muell.) Par. var. *appressus* Card. nom. nud.

Type specimens: *Trachypus bicolor* Reinw. et Hornsch. var. *hispidus* (C. Muell.) Card.: India, Madura, Kodaikanal, leg. Foreau, 20-1-1912, No. 36; neoholotype in FH. — *Trachypus rigidus* Broth. et Par.: Japan, Shikoku, Mt. Tsurugi-zan, leg. Faurie, No. 1394; type not seen. — *Trachypus paulensis* (Broth.) Broth.: Brazil, Prov. of Sao Paulo, distr. Apiahy, Chapeu, leg. Puiggari, 8-1880, No. 615; lectoholotype in H. — *Trachypus molliculus* Broth. et Par.: French Guinea, Fouta Jalon, leg. Pobeguin, 8-1909, No. 1848; holotype in H, isotype in PC. — *Trachypus rhacomitrioides* Broth.: China, Hunan, near Hsinhwa, leg. Handel-Mazzetti, 25-5-1918, No. 11940; holotype in H. — *Trachypus bicolor* Reinw. et Hornsch. var. *brevifolius* Broth.: China, Yuennan, Golo, leg. Handel-Mazzetti, 30-8-1915, No. 7926; holotype in H.

Fairly slender to *medium sized* plants, greenish or brownish, often *black* or dark brown below and *yellowish-green at tips.* Stems rather densely pinnately to remotely, irregularly pinnately branched, *rigid, densely foliate,* up to *6 cm* long. Leaves *appressed to erect spreading* when dry, up to *3 mm* long.

INDIA: Sikkim: near Kurseong, Punkabari, leg. Decoly and Schaul, 16-12-1899, No. 2312 (FH, H, PC, T. decolyi). — Mangalore: South Canara, leg. Pfeiderer, 1904, No. 6492 (H); South Canara, Western Ghats, leg. Pfeiderer, 5-1905, No. 28, c.fr. (H). — Nilgiris: Hohenacker (L); ex herb. Montagne (L); Avalanche, leg. Gambler, 11-1883, No. 13310, c.fr. (H). — Madura: Palni Hills: Kodaikanal, leg. Decoly, 1898, No. 818 (H, T. micro-bicolor); Kodaikanal, leg. André, 5-1909, No. 146 (PC, T. subpiliferus); Kodaikanal, leg. Foreau, 1911, No. 41 (PC, T. hispidus var. appressus); Kodaikanal, leg. Foreau, 20-1-1912, No. 36 (FH, neoholotype); Shembaganur, leg. Foreau, 5-1956, No. 211 and 211a (GRO).

CEYLON: Nuwara Elyia, leg. Queste, 1910, No. 2 (H, T. nietneri).

CHINA: Hunan: Hsinhwa, leg. Handel-Mazzetti, 25-5-1918, No. 11940 (H, T. rhacomitrioides, holotype). — Yuennan: Golo, leg. Handel-Mazzetti, 30-8-1915, No. 7926, c.fr. (H, T. bicolor var. brevifolius, holotype).

JAPAN: Honshiu: Prov. of Sagami, Mt. Hiru, leg. Sasaoka, 3-10-1926, No. 2607 (H). — Shikoku: Prov. of Iyo, Mt. Ishizuchi, leg. Cono, 5-9-1906, No. 23 (H, T. rigidus).

BURMA: Pegu, leg. Kurz, No. 2926 (H, Papillaria nana).

ANNAM: Lang Biang, leg. Micholitz, 27-11-1903, No. 289 (H, T. annamensis).

LAOS: Tran-niuh, leg. Micholitz, 3-1909 (L, T. annamensis).

TANGANYIKA: Usambara, leg. Pandarang Joshi, 12-1903, No. 5630 (H, T. usambaricus).

FRENCH GUINEA: Fouta Jalon, leg. Pobeguin, 8-1909, No. 1848 (H, T. molliculus, holotype and PC, isotype).

BRAZIL: Prov. of Santa Catharina: Serra Geral, leg. Ule, 3-1891, No. 1147 (H, T. pterygonocaulos); Serra do Itatiaia, near Rio de Janeiro, leg. Dusin, 22-7-1902, No. 1576 (H, T. paulensis). — Prov. or Sao Paulo: distr. Apiahy, Chapeu, leg. Puiggari, 8-1880, No. 615 (H, T. paulensis, lectoholotype).

Distribution: Ceylon; India; Lower Burma; China (Hunan, Yuennan); Laos; Annam; Japan; Tanganyika; French Guinea; South-East Brazil. Rather common.

Ecology: On trees and on rocks. Alt.: 900—2500 m.

Notes. 1. This variety is very closely allied to var. *bicolor* and differs mainly in being more slender, with shorter stems and branches and with smaller leaves.

The variation in the colour, in the shape of the leaves and in the sporophyte is the same as in var. *bicolor.*

There occur many intermediate forms with var. *bicolor* and with var. *viridulus* (Mitt.) Zant.

2. The close alliance between var. *hispidus* and var. *bicolor* was remarked on by Cardot where he writes (l. c. 1905): "Je considère le *T. bicolor* comme un type très polymorphe, englobant le *Papillaria sinensis* C. Muell. (*T. sinensis* Par.), le *T. hispidus* (C. Muell.) Par. et le *T. rigidus* Broth. et Par. Les différences qui existent entre ces diverses formes sont peu importantes et très peu stables, et n'affectent guère que les dimensions et le port des plantes. Le *T. hispidus*, des Nilgherris et de Ceylan, diffère du *T. bicolor* type, de Java, par ses dimensions plus faibles, ses tiges et ses rameaux plus courts, ses feuilles plus courtes et moins larges à la base; il n'y a pas de différence appréciable dans le tissu. Certains échantillons restent indécis entre le *T. hispidus* et le *T. bicolor.*"

3. *T. molliculus* Broth. et Par. from French Guinea and *T. subpiliferus* P. Vard. nom. inval. from Madura (India) incline somewhat towards var. *viridulus* (Mitt.) Zant. in having flaccid stems and branches, but the direction of the leaves and — with respect to *T. molliculus* the colouration too — are exactly the same as in var. *hispidus.*

4. *T. rhacomitrioides* (Hunan), *T. decolyi* (Sikkim), *T. micro-bicolor* (India), *Papillaria nana* (Burma), *T. usambaricus* (Usambara) and *T. paulensis* (Brazil) differ from the typical form of var. *hispidus* in being even more slender, but there is not any other difference, with the exception of *T. decolyi,* which has also got small, but distinct auricles and therefore inclines somewhat towards *T. appendiculatus* (Ren. et Card.) Broth.

Of *T. paulensis* only the type specimen is somewhat more slender than the typical form of var. *hispidus,* the other specimens from Brazil (also identified as *T. paulensis,* or as *T. pterygonocaulos*) are of the same size as *T. bicolor* var. *hispidus.*

1c. **Trachypus bicolor** Reinw. et Hornsch. var. **viridulus** (Mitt.) Zant. comb. nov. — Plate I, Map 3.

Trachypus viridulus (Mitt.) Broth., Nat. Pfl. 1, 3(1906)830; ibid. ed. 2, 11(1925)119; Leon, Ann. Crypt. Exot. 6, 2(1933)193; Thériot, Mem. Soc. Hist. Nat. Fel. Poey Cubana 14, 4(1940)356; Bartram, Field. Bot. 25(1949)248.

Neckera viridula Mitt., Kew J. of Bot. 3(1851)351.

Meteorium viridulum (Mitt.) Mitt., J. Linn. Soc. Bot. 12(1869)443.

Papillaria viridula (Mitt.) Jaeg., Ber. S. Gall. Naturw. Ges. 1875/76(1877)267 = Ad. 2(1877)171; Paris, Ind. Bryol. (1897)909; ibid. ed. 2, 3(1905)361.

Papillaria molleri C. Muell., Fl. 69(1886)283; Paris, Ind. Bryol. (1897) 907; ibid. ed. 2, 3(1905)357.

Trachypus molleri (C. Muell.) Broth. syn. nov.: Brotherus, Nat. Pfl. 1, 3(1906)830; ibid. ed. 2, 11(1925)119.

Papillaria laeta Ren. et Card., Bull. Soc. Roy. Bot. Belg. 30, 2(1892) 192; Paris, Ind. Bryol. (1897)906.

Trachypus laetus (Ren. et Card.) Broth. syn. nov.: Brotherus, Nat. Pfl. 1, 3(1906)829; Paris, Ind. Bryol. ed. 2, 5(1906)64; Fleischer, Musci Fl. Buitenzorg 3(1908)746; Renauld, Prodr. Fl. Bryol. Madagascar Suppl. (1909)65; Thériot, Bull. Soc. Havraise Etud. Div. 1932(1932)143.

Trachypus subbicolor C. Muell. ex Card. syn. nov.: Paris, Ind. Bryol. (1898)1304 (as nom. nud.); ibid. Suppl. (1900)322; Cardot, Beih. Bot. Centralbl. 19, 2(1905)116; Fleischer, Musci Fl. Buitenzorg 3(1908)743; Brotherus, Philipp. J. Sc. 3, 1, C, Bot. (1908)24; ibid. 5, 2, C, Bot. (1910) 154; ibid. 8, 2, C, Bot. (1913)79.

Papillaria subbicolor (C. Muell.) Jaeg. nom. nud.: Jaeger, Ber. S. Gall. Naturw. Ges. 1875/76(1877)273 = Ad. 2(1877)177.

Trachypus cuspidatus Fleisch. var. *brevifolia* Fleisch. syn. nov.: Fleischer, Musci Fl. Buitenzorg 3(1908)743.

Trachypus bicolor Reinw. et Hornsch. var. *hispidus* (C. Muell.) Card. f. *flagelliformis* Fleisch. syn. nov.: Fleischer, Musci Fl. Buitenzorg 3(1908) 741; Herzog, Hedwigia 50(1910)135 (erroneously as f. flagelli*fera* Fleisch.).

Trachypus subbicolor Card. f. *robusta* Broth. syn. nov.: Brotherus, Symb. Sin. 4(1929)76.

Trachypus haleakalae Broth. nom. nud.: Brotherus, Bull. Soc. Bot. Ital. 1904(1904)24; Bartram, Bish. Mus. Bull. 101(1933)162.

Trachypus mexicanus Broth. nom. nud.

Trachypus mollis Broth. nom. nud.

Trachypus subhumilis Broth. nom. nud.: Brotherus, Nat. Pfl. ed. 2, 11(1925)119.

Trachypus sublaetus Broth. nom. nud.

Type specimens: *Trachypus viridulus* (Mitt.) Broth.: Ecuador, near Quito, leg. Jameson; type not seen. — *Trachypus molleri* (C. Muell.) Broth.: Africa, Isle of S. Thomé, leg. Moller, 1885, No. 21; holotype in H. — *Trachypus laetus* (Ren. et Card.) Broth.: Madagascar, Diego Suarez, leg. Chenagon; isotype in H. — *Trachypus subbicolor* Card.: Himalaya, ex herb. Ind. Or. Hook. f. et Thoms. No. 843; lectotype in L. — *Trachypus cuspidatus* Fleisch. var. *brevifolia* Fleisch.: West-Java, Tjibodas, Huis ten Bosch, leg. Fleischer; holotype in FH. — *Trachypus bicolor* Reinw. et Hornsch. var. *hispidus* (C. Muell.) Card. f. *flagelliformis* Fleisch.: Ceylon, Horton Plaines, leg. Fleischer; holotype in FH. — *Trachypus subbicolor* Card. f. *robusta* Broth.: China, Yuennan, Djiou-djiang (upper course of the river Irrawady), leg. Handel-Mazzetti, 9-7-1916, No. 9474; type probably lost.

Fairly slender to *medium sized* plants, greenish or brownish, *not blackish*. Stems rather densely pinnately to remotely, irregularly branched, mostly *flaccid, rather laxly to more or less densely*, sometimes somewhat complanately foliate, up to *15 cm* long. Leaves mostly *horizontally spreading* when dry, up to *3 mm* long, either ending in a hyaline hairpoint or not; leaf margin entire or finely denticulate.

INDONESIA: Java: Mt. Pangerango and Gedeh: Tjibodas, Huis ten Bosch, leg. Fleischer (FH, T. cuspidatus var. brevifolia, holotype); above Tjibodas, leg. Schiffner, 4-1894, No. 10856 and 10758 (L, T. cuspidatus); Mt. Telaga Bodas: leg. Schiffner, 15-2-1894, No. 10842 (L, T. bicolor); Mt. Tjikoeraj: leg. Nyman, 6-11-1898, No. 328 (H, T. cuspidatus).

PHILIPPINE ISLANDS: Luzon: Prov. of Nueva Vizcaya, leg. MacGregor, 1-1913, No. 212, For. Bur. No. 20222 (H, T. subhumilis).

FORMOSA: leg. Faurie, 6-1903 (PC, T. bicolor var. rigidus).

NEPAL: Khatmandu, leg. Rana, 1900 (FH, T. subbicolor).

INDIA: Sikkim: leg. Kurz, No. 208b (L, T. subbicolor); Darjeeling, leg. Long, 18-11-1907, No. 7624 (H, T. subbicolor); Kurseong, leg. Decoly and Schaul, 10-1898, c.fr. (FH, T. subbicolor). — Himalaya without definite locality: ex herb. Ind. Or. Hook. f. et Thoms. No. 843 (L, T. subbicolor, lectotype).

CEYLON: Horton Plaines, leg. Fleischer (FH, T. bicolor var. hispidus f. flagelliformis, holotype).

UPPER BURMA: leg. Fraser, 1896 (H, T. subbicolor).

ANNAM: Lang Biang, leg. Micholitz, 3-1911 (PC, T. mollis).

MADAGASCAR: Diego Suarez, leg. Chenagon (H, T. laetus, isotype); Prov. of Betafo, leg. ? 1901, ex herb. Paris (L, Papillaria laeta).

TRANSVAAL: Lydenburg, leg. Wilms, 12-1890, No. 2486 (L, T. sublaetus).

ISLE OF S. THOMÉ: leg. Moller, 1885, No. 21 (H, L, T. molleri, holotype).

MEXICO: Zacuapan, Vera Cruz, leg. Purpus, 12-1918, No. 8319 (H, T. mexicanus).

GUATEMALA: San Marcos, leg. Sharp, 25-2-1946, No. 5487 (herb. Bartram, T. viridulus).

Distribution: Java, Luzon, Formosa, Nepal, Himalaya, Ceylon, Burma, Annam, Madagascar, Transvaal, Isle of S. Thomé, Mexico, Guatemala, Costa Rica, Cuba, Ecuador.

Ecology: On trees and on rocks, from low altitude up to 3000 m.

Notes. 1. This variety differs from var. *hispidus* (C. Muell.) Card. in the following characters:

a. not blackish,

b. stems mostly flaccid,

c. leaves mostly horizontally spreading, crisped near apex,

and from var. *bicolor*, in addition to the above mentioned characters, in its less robust habit.

Moreover the stems and branches are sometimes somewhat complanately, laxly foliate, which is not the case in var. *bicolor* or var. *hispidus*.

2. This variety may vary somewhat in size. The specimens identified as *T. molleri* (C. Muell.) Broth., *T. laetus* (Ren. et Card.) Broth. and *T. subhumilis* Broth. nom. nud. for instance are slightly less robust than the typical form.

The variation in the shape of the leaves and the leaf cells is the same as in var. *bicolor*.

3. One specimen, described by Fleischer as *T. bicolor* var. *hispidus* f. *flagelliformis* Fleisch. (l. c. 1908), from Ceylon is distinguished in having rather long, flagelliform branches, which are laxly foliate with small leaves, but, although in a less extreme manner, this also occurs in many other specimens, so that in my opinion it is not practical to separate those plants.

4. Some plants of this variety have small, but distinctly denticulate leaf margins (Nepal, leg. Rana, 1900 and Sikkim, Kurseong, leg. Decoly and Schaul, 10-1898, both in FH; *cf.* Fleischer, l. c. 1908 p. 743, Bemerkung).

5. For practical reasons I grouped the many intermediate forms between var. *viridulus* and var. *bicolor* mostly among var. *bicolor*.

1d. Trachypus bicolor Reinw. et Hornsch. var. **scindifolius** (Sak.) Nog. — Plate I, Map 2.

Trachypus bicolor Reinw. et Hornsch. var. *scindifolius* (Sak.) Nog., J. Hattory Bot. Lab. (= J. Hattori Shokub. Kenk.) 2(1947)53.

Trachypus scindifolius Sak., Bot. Mag. Tokyo 55(1941)208.

Type specimen: Formosa, Prov. of Taityu, Eki-ju-kei, leg. Koizumi, 8-1938; holotype in herb. Sakurai, No. 13948 (not seen).

Robust plants without any black colouring. Stems irregularly pinnately branched, *densely foliate*. Leaves distinctly *falcate-second*, undulate in the upper part, *easily tearing*, up to *4 mm* long.

Distribution: Formosa only.

Ecology: On trees.

I have not seen this variety.

Notes. 1. According to the description by Sakurai (l. c. 1941) the main differences with the closely allied var. *bicolor* are:

a. leaves undulate in the upper part,

b. leaves strongly falcate-second, easily tearing,

c. plant without any black colouring.

However all these characters occasionally also occur in var. *bicolor*,

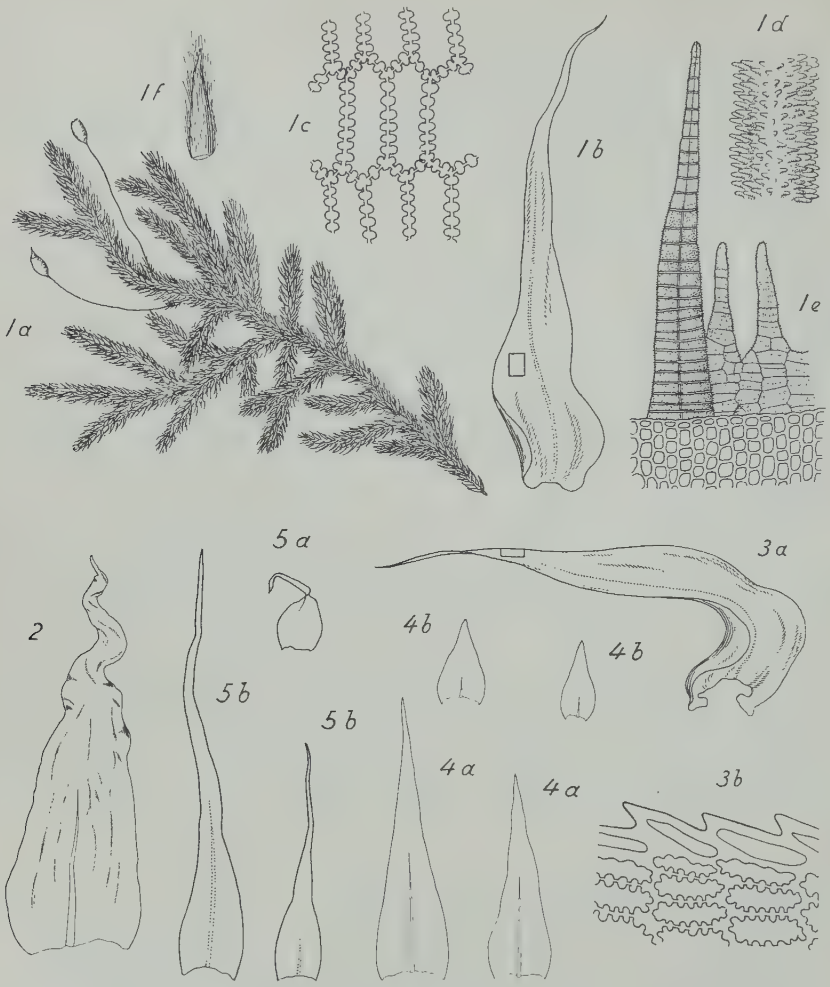
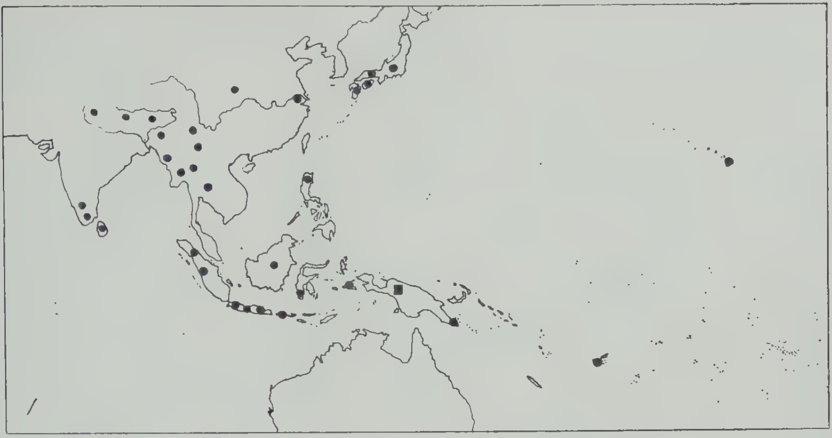


Plate II. — Fig. 1: *Trachypus bicolor* Reinw. et Hornsch. var. *bicolor*, 1a habit (1/1), 1b leaf (20/1), 1c leaf cells (300/1), 1d part of seta (30/1), 1e peristome (100/1), 1f calyptra (5/1); Fig. 2: *Trachypus perplicatus* Dix., leaf (20/1); Fig. 3: *Trachypus appendiculatus* (Ren. et Card.) Broth., 3a leaf (25/1), 3b leaf cells (300/1); Fig. 4: *Trachypus humilis* Lindb. var. *humilis*, 4a stem leaves (25/1), 4b branch leaves (25/1); Fig. 5: *Trachypus longifolius* Nog., 5a lower stem leaf (35/1), 5b upper stem or branch leaf (35/1). (Fig. 1a, b, d, e, f after Bryol. Jav. 2(1864) Tab. 211, Fig. 5 after Noguchi, J. Hattori Bot. Lab. 2(1947)55, Fig. 1c, 2, 3 and 4 original).

Plate III. — Map 1: Area of *Trachypus bicolor* Reinw. et Hornsch. var. *bicolor* (●); (Borneo without definite locality) and of *Trachypus perplicatus* Dix. (■); Map 2: Area of *Trachypus humilis* Lindb. var. *humilis*; Map 3: Area of *Trachypus humilis* Lindb. var. *tenerrimus* (Herz.) Zant. (●) and of *Trachypus longifolius* Nog. (■).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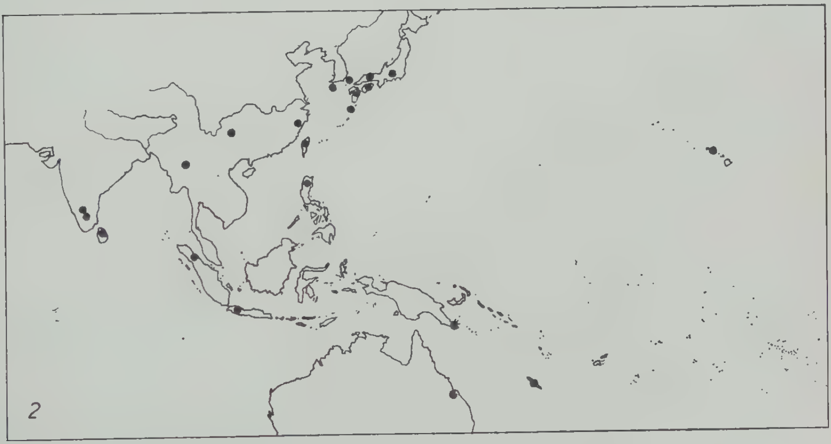
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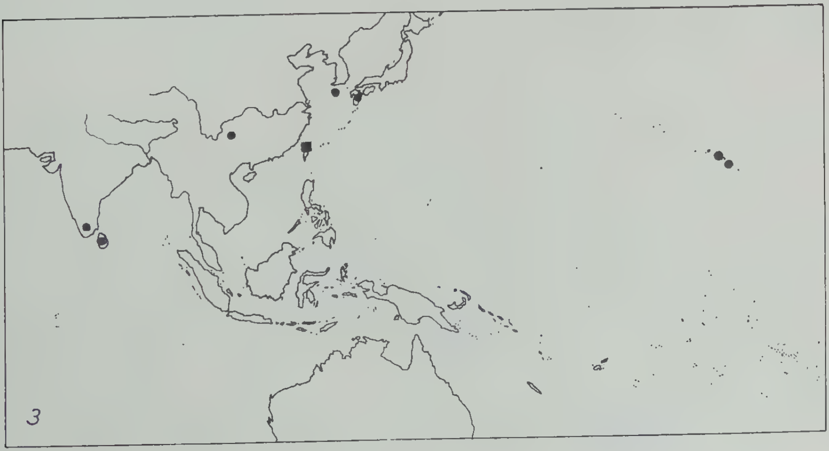
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although mostly in a less extreme manner and whether this variety is a stable one will have to be investigated with the help of further material.

2. On account of the undulate leaves this variety inclines somewhat towards *T. perplicatus* Dix. from Dutch New Guinea, which species has however not got falcate-second leaves and is tinged with black.

2. **Trachypus perplicatus** Dix. — Plate II, Fig. 2. Plate III, Map 1. Dixon, Farl. 1, 1(1943)35.

Type specimen: Dutch New Guinea, Mt. Carstensz, Meerendal, leg. Wissel, 11-12-1936, No. 14; holotype in BM, isotypes in GRO and L.

Fairly robust, yellowish-brown plants, *tinged with black,* in dull mats. Stems rather densely pinnately branched, up to 6 cm long. Stems and branches densely foliate, rigid. Leaves erect spreading to spreading when dry, spreading to horizontally spreading when moist, up to *4 mm* long, *strongly longitudinally plicate and strongly undulate in the upper half,* from an ovate, not auriculate base, gradually, rather long-acuminate, ending in a hairpoint; leaf margin minutely denticulate, crenulate. Leaf rib single, *ending far below apex.* Leaf cells elongate to linear, about 6—12 times as long as wide, more elongate towards base, border cells not differentiated; alar cells absent or hardly developed; cell walls incrassate, strongly crenulate by numerous papillae; papillae towards base less distinct.

Sporophyte not known.

DUTCH NEW GUINEA: Mt. Carstensz, Meerendal, leg. Wissel, 11-12-1936, No. 14 (GRO, L, isotypes).

Distribution: Dutch New Guinea only.

Ecology: Alt.: 4000—4100 m.

Note. This species is closely allied to *T. bicolor* Reinw. et Hornsch. var. *bicolor,* but is clearly differentiated in having leaves which are, dry as well as moist, strongly undulate in the upper part. Moreover the leaf cells are somewhat more elongate and the leaf rib slightly shorter.

Whether these differences are stable ones will have to be investigated with the help of further material, but the undulate leaves are such a striking feature that in my opinion it is justified to consider this plant to be a separate species, unless many intermediate forms should become known (*cf. T. bicolor* var. *scindifolius* (Sak.) Nog., note 2).

3. **Trachypus appendiculatus** (Ren. et Card.) Broth. — Plate II, Fig. 3. Plate I, Map 2.

Trachypus appendiculatus (Ren. et Card.) Broth., Nat. Pfl. 1, 3(1906) 829; Renauld, Prodr. Fl. Bryol. Madagascar Suppl. (1909)65; Brotherus, Nat. Pfl. ed. 2, 11(1925)119.

Papillaria appendiculata Ren. et Card., Bull. Soc. Roy. Bot. Belg. 32, 1(1894)108; Paris, Ind. Bryol. (1897)901; ibid. ed. 2, 3(1905)351.

Type specimen: Madagascar, between Fianarantsoa and Mananjary, leg. Besson; type probably lost. Neotype: Himalaya, ex herb. Bescherelle (PC).

Medium sized, yellowish-brown plants, scarcely tinged with black, in dull mats. Secondary stems procumbent or somewhat ascending, up to 6 cm long, rather densely to remotely pinnately branched. Secondary stems and branches densely, not complanately foliate, rigid, branches up to 1 cm long. Leaves horizontally spreading, *strongly recurved when dry*, up to *3 mm* long, somewhat longitudinally plicate, from an ovate or broadly ovate, *auriculate* base, gradually or somewhat abruptly, rather long-acuminate, not ending in a hairpoint; leaf margin plane, *entire or faintly denticulate, crenulate in the lower half and moderately serrate and not crenulate in the upper half*. Auricles small, but distinct, mostly somewhat protruding. Branch leaves somewhat smaller and with smaller auricles than the stem leaves. Leaf rib single, ending below apex. Leaf cells elongate-hexagonal, 2.5—6 times as long as wide, more elongate towards base, cells in the auricles smaller; alar cells absent or few, quadrate to hexagonal; cell walls incrassate to very incrassate, very strongly crenulate by numerous low papillae, towards base gradually passing into smooth cell walls (cell walls of the cells near the auricles however crenuate), *cell walls of the border cells in the upper half of the leaf smooth.*

Sporophyte not known.

INDIA: Himalaya, ex herb. Bescherelle (PC, T. subbicolor; neoholotype of T. appendiculatus).

Distribution: Himalaya, Madagascar.

Ecology: On trunks.

Notes. 1. This species bears resemblance to *T. bicolor* Reinw. et Hornsch. var. *hispidus* (C. Muell.) Card., but differs by the following characters:

a. leaves strongly recurved when dry,
b. leaves with small, but distinct auricles,
c. leaf margin in the upper half moderately serrate,
d. cell walls of the border cells in the upper part of the leaf smooth, not crenulate.

Rarely however small auricles also occur in *T. bicolor* var. *hispidus* (see there, note 4).

2. I have not received the type specimen from PC (probably lost), but another specimen (ex herb. Bescherelle, Himalaya, under the name of *T. subbicolor*) which in general fits the description by Renauld and Cardot. I made the above description by means of this specimen.

4. **Trachypus humilis** Lindb.

For literature and type specimens see below.

Dioicous; *slender to very slender*, yellowish-green or brownish, sometimes blackish plants in dull, dense mats. Secondary stems up to 3 cm long, procumbent or ascending, mostly densely pinnately, occasionally somewhat bipinnately branched. Secondary stems and branches densely foliate all around stem, leaves occasionally faintly to distinctly falcate-second. Plants often with rather few to numerous, mostly rather short, more or less laxly foliate flagelliform branches, which easily break off. Branches attenuate or hamate at tips by crowded apical leaves. *Leaves dimorphous.* Stem leaves appressed to horizontally spreading when dry, erect spreading to horizontally spreading when moist, up to *2 mm* long, from an ovate or broadly ovate, not or faintly auriculate base, mostly gradually, rather long-acuminate, plane or longitudinally plicate, either ending in a hyaline hairpoint or not; leaf margin plane or more or less recurved, mostly *faintly denticulate,* crenulate. Leaf rib single, *rather faint, ending about midleaf.* Branch leaves up to 1.4 mm long, sometimes somewhat hollow and carinate, shorter acuminate than the stem leaves; leaf rib single, faint, ending below midleaf or scarcely developed; further like the stem leaves. Leaves of the flagelliform branches small, often very narrow, entire to very faintly denticulate, without rib. Leaf cells hexagonal to elongate, sometimes more or less linear, about 2—10 times as long as wide, more elongate towards base; border cells not differentiated; alar cells few or scarcely developed, quadrate to rectangular; cells walls incrassate, strongly crenulate by numerous papillae, cell walls of basal cells smooth.

Sporophyte as in the diagnosis of the genus.

Peristome not known. Calyptra *cucullate,* pilose, with long, erect spreading hairs (fid. Bartram, l. c. 1939).

This species is rather variable with 2 varieties which may be distinguished by the following key:

1. Slender plants; stem leaves up to 2 mm long; branches often hamate at tips 4a. var. **humilis**
1. Very slender plants; stem leaves up to 1 mm long; branches mostly attenuate at tips . . . . 4b. var. **tenerrimus** (Herz.) Zant.

There occur some plants which are intermediate between the 2 varieties.

4a. Trachypus humilis Lindb. var. **humilis.** — Plate II, Fig. 4. Plate III, Map 2.

Trachypus humilis Lindb., Act. Soc. Sc. Fenn. 10(1872)230; Paris, Ind. Bryol. (1898)1303; Paris, Bull. Herb. Boiss. 2, 2(1902)926; Paris, Ind. Bryol. ed. 2, 5(1906)64; Brotherus, Nat. Pfl. 1, 3(1906)829; Brotherus, Philipp. J. Sc. 8, 2, C, Bot. (1913)80; Williams, Bull. New York Bot. Gard. 8, 31(1914)357; Okamura, J. Coll. Sc. Imp. Univ. Tokyo 38(1916)37; Brotherus, Nat. Pfl. ed. 2, 11(1925)119; Brotherus, Symb. Sin. 4(1929)76; Bruehl, Rec. Bot. Surv. India 13, 1(1931)67; Thériot, Ann. Crypt. Exot. 5, 3/4(1932)177; Potier de la Varde, Rev. Bryol. Lich. 10(1938)141; Sakurai, Bot. Mag. Tokyo 52(1938)472; Bartram, Philipp. J. Sc. 68(1939)194; Noguchi, J. Hattori Bot. Lab. (= J. Hattori Shokub. Kenk.) 2(1947)54; Noguchi, J. Hattori Bot. Lab. 5(1951)16; Sakurai, Musc. Jap. (1954)100; Amakawa and Osada, J. Hattori Bot. Lab. 17(1956)48.

Papillaria humilis (Lindb.) Broth., Hedwigia 38(1899)227.

Trachypus massarti Ren. et Card. syn. nov.: Renauld et Cardot, Rev. Bryol. 23(1896)103; Cardot, Ann. Jard. Bot. Buitenzorg Suppl. 1(1897)17; Paris, Ind. Bryol. (1898)1303; ibid. ed. 2, 5(1906)64; Brotherus, Nat. Pfl. 1, 3(1906)829; Fleischer, Musci Fl. Buitenzorg 3(1908)744; Dixon, J. of Bot. 53(1915)290; Potier de la Varde, Rev. Bryol. 50(1923)73; Moeller, Hedwigia 60(1919)321; Brotherus, Nat. Pfl. ed. 2, 11(1925)119; Bruehl, Rec. Bot. Surv. India 13, 1(1931)67; Foreau, J. Madras Univ. ? (about 1931)?; Bartram, Britt. 9, 1(1957)45.

Trachypus novae-caledoniae C. Muell. ex Thér. syn. nov.: Thériot, Bull. Acad. Int. Géogr. Bot. 20(1910)101; Brotherus, Oefv. Finsk. Vet. Soc. Foerh. 53, A, 11(1911)27; Brotherus, Nat. Pfl. ed. 2, 11(1925)119.

Trachypus dimorphus Dix. et P. Vard. syn nov.: Dixon and Potier de la Varde, Ann. Crypt. Exot. 1, 1(1928)42.

Claopodium kiusiense Sak., Bot. Mag. Tokyo 46(1932)378; Noguchi, J. Hattori Bot. Lab. (= J. Hattori Shokub. Kenk.) 2(1947)54 (fid. Noguchi).

Anomodon rostratus (Hedw.) Schimp. var. *japonicus* Sak., Bot. Mag. Tokyo 46(1932)743; Noguchi, J. Hattori Bot. Lab. (= J. Hattori Shokub. Kenk.) 2(1947)54; Sakurai, Musc. Jap. (1954)100 (fid. Noguchi and Sakurai).

Claopodium undulatifolium Sak., Bot. Mag. Tokyo 47(1933)338; Noguchi, J. Hattori Bot. Lab. (= J. Hattori Shokub. Kenk.) 2(1947)54 (fid. Noguchi).

Trachypus massarti Ren. et Card. var. *brachyphyllus* Fleisch. syn. nov.: Fleischer, Musci Fl. Buitenzorg 3(1908)745.

Trachypus humilis Lindb. var. *brevifolius* Card. syn. nov.: Cardot, Bull. Soc. Bot. Genève 3, 2(1911)276; Noguchi, J. Hattori Bot. Lab. (= J. Hattori Shokub. Kenk.) 2(1947)54; Sakurai, Musc. Jap. (1954)100.

Trachypus humilis Lindb. var. *major* Broth. syn. nov.: Brotherus, Symb. Sin. 4(1929)76.

Trachypus humilis Lindb. f. *secundus* Nog. syn. nov.: Noguchi, J. Hattori Bot. Lab. (= J. Hattori Shokub. Kenk.) 2(1947)54; Sakurai, Musc. Jap. (1954) 100.

Type specimens: *Trachypus humilis* Lindb.: Japan, Kiushiu, Nagasaki, leg. ?, 5-4-1863; type not seen. — *Trachypus massarti* Ren. et Card.: Indonesia, Java, leg. Massart, 1895, No. 1501; isotype in L. — *Trachypus novae-caledoniae* Thér.: New Caledonia, leg. Vieillard; holotype in PC. — *Trachypus dimorphus* Dix. et P. Vard.: India, Nilgiris, Kotagiri, leg. Sedgwick, 5-1915, No. 706; type in PC. — *Trachypus massarti* Ren. et Card. var. *brachyphyllus* Fleisch.: Indonesia, Java, Tjibodas, leg. Fleischer; type probably lost. — *Trachypus humilis* Lindb. var. *brevifolius* Card.: Korea, Isle of Quelpart, leg. Faurie, 1906, No. 235; holotype in PC. — *Trachypus humilis* Lindb. var. *major* Broth.: China, Prov. of Kwei-Chow, Dodjie, leg. Handel-Mazzetti, 13-7-1917, No. 10738; holotype in H. — *Trachypus humilis* Lindb. f. *secundus* Nog.: Japan, Kiushiu, Prov. of Kumamoto, leg. Noguchi, 10-8-1930, No. 4423; type in herb. Noguchi.

Slender plants, without or with rather few flagelliform branches. Branches often *hamate* at tips by crowded apical leaves. Stem leaves up to *2 mm* long.

Japan: Honshiu: Prov. of Ise, Sakamoto, leg. Kawasuki, No. 72 (H). — Shikoku: Prov. of Tosa, Hogasho, leg. Yoshinaga, 10-1903, No. 1 (H); Mt. Osugi, leg. Oda, 29-3-1913, No. 1557 (H). — Kiushiu: Nagasaki, leg. Wichura, 18-1-1861, No. 1473a (H); Prov. of Kumamoto, leg. Noguchi, 10-8-1930, No. 4423 (herb. Noguchi, T. humilis f. secundus, isotype); Miyazaki, Kitago, leg. Noguchi and Hattori, 4-1950, No. 177 (GRO, L, T. humilis f. secundus); Miyazaki, Minaminaka, Sakatani, leg. Noguchi and Hattori, 4-1946, No. 2 (GRO, L, T. humilis var. brevifolius). — Riu-Kiu Islands: Yaku Shima, leg. Faurie, No. 1225 (PC).

Korea: Isle of Quelpart, leg. Faurie, 1906, No. 235 (H, T. humilis var. brevifolius, holotype).

Philippine Islands: Luzon, Subprov. of Benguet, leg. Merrill, 5-1911, No. 7839 (K).

Indonesia: Java: Tjibodas, leg. Massart, 1895, No. 1501 (L, T. massarti, isotype); Tjibodas, leg. Dadi and Noerta, 28-3-1949, No. 53 (GRO); Mt. Tjikoeraj, Priangan, leg. Verdoorn, 7-1930, No. 740 (GRO, T. massarti var. brachyphyllus); Mt. Tjikoeraj, leg. Verdoorn, 7-1930, No. 59 (GRO, L, T. massarti var. brachyphyllus); Tjibodas, leg. van der Wijk, 4-5-1952, No. 976 (GRO); Mt. Salak, leg. Moeller, 1-6-1897 (H, T. massarti). — Sumatra: Bandarbaroe, leg. Staal, 29-11-1949, No. 213 (GRO); Berastagi, leg. Staal, 23-3-1950, No. 370 (GRO); Mt. Pisopiso, Karo plateau, leg. van der Wijk, 21-6-1952, No. 1789 (GRO).

Australia: Queensland, leg. Watts, 29-7-1913, No. 633 (H, T. novae-caledoniae).

Hawaiian Islands: Kauai, leg. Degener, 31-12-1957, No. 21615, ex herb. Schallert (GRO).

New Caledonia: leg. Vieillard (PC, T. novae-caledoniae, holotype).

India: Nilgiris, Kotagiri, leg. Sedgwick, 5-1915 (PC, T. dimorphus, holotype).

China: Prov. of Kwei-Chow, Dodjie, leg. Handel-Mazzetti, 13-7-1917, No. 10738 (H, T. humilis var. major, holotype).

Upper Burma: Nam Tamai Valley, leg. Kaulbach, 14-8-1938, herb. Dixon, ref. No. 2a (BM, T. pilifolius).

Distribution: Japan; Isle of Quelpart (Korea); Luzon; China (Kwei-Chow, Che-Kiang); Formosa; Upper Burma; India (Nilgiris, Madura); Ceylon; Indonesia (Java, Sumatra); Australian New Guinea; Australia (Queensland); New Caledonia Hawaiian Islands.

Not found very frequently, but may often have been overlooked.

Ecology: On rocks and on trees, from low altitudes up to 2300 m.

Notes. 1. This variety is a rather variable one, and may vary in a) the colour, b) the direction and the aspect of the leaves, c) the shape of the leaves and d) the shape of the leaf cells.

a) The colour is mostly yellowish-green or brownish, but there occur some plants which are more or less blackish in the lower parts. One specimen from China (Kwei-Chow, leg. Handel-Mazzetti, 13-7-1917, No. 10738, *T. humilis* var. *major*) for instance is blackish in the lower parts whereas the upper parts of the branches are yellowish-green. Moreover this plant is somewhat more robust and, on account of these facts inclines somewhat towards *T. bicolor* var. *hispidus*, but the leaves are distinctly dimorphous and the leaf rib ends about midleaf as it does in *T. humilis*.

b) The leaves are mostly appressed to spreading when dry (occasionally horizontally spreading), not falcate-second. There occur some plants however all or part of the leaves of which are falcate-second, *viz.* the plant from China mentioned under a) and the plants from Japan identified as *T. humilis* var. *secundus* Nog. In my opinion it is not practical to separate these plants, because the difference is not essential, and because the form with the falcate-second leaves gradually passes into the normal form.

The branches are often hamate at the ends, but on the same plant may also occur branches which are attenuate. In some specimens all branches are attenuate.

c) The shape of the leaves is rather variable. The stem leaves are mostly rather long-acuminate; the branch leaves vary however from rather long- to short-acuminate. A plant from Korea (Isle of Quelpart) with rather short-acuminate leaves was described by Cardot as *T. humilis* var. *brevifolius* Card. (l. c. 1911). The long- and the short-acuminate leaves gradually pass into each other, sometimes even on the same plant.

There occur some plants (*e. g.* Upper Burma, Nam Tamai Valley, leg. Kaulbach, 14-8-1938 (BM)) which incline somewhat towards *T. bicolor* Reinw. et Hornsch. var. *hispidus* (C. Muell.) Card. or towards *T. bicolor* var. *viridulus* (Mitt.) Zant. on account of their having scarcely dimorphous leaves. The stems leaves are only slightly longer acuminated than the branch leaves, as it does sometimes in var. *hispidus* or var. *viridulus,* but the slender habit and the short leaf rib are the same as in *T. humilis* Lindb. var. *humilis.*

d) The shape of the leaf cells varies from 2—10 times as long as wide. The cells of the stem leaves are often slightly more elongate than those of the branch leaves. Some plants from New Caledonia (described by Thériot as *T. novae-caledoniae* Thér., l. c. 1910) are characterized by having larger leaf cells, up to about 50 μ long (normal length up to 35 μ).

2. The type specimen of *T. massarti* Ren. et Card. var. *brachyphyllus* Fleisch. did not appear to be present in FH and has probably been lost, but according to the diagnosis (l. c. 1908) this variety falls within the limits of *T. humilis.*

3. The very close resemblance between *T. massarti* Ren. et Card. and *T. humilis* was remarked on by Fleischer where he writes (l. c. 1908): "Die Varietät (= *T. massarti* var. *brachyphyllus*) kommt durch die auffällig kurz gespitzten Blätter, welche durch Uebergänge mit der langblättrigen Form verbunden sind, dem *Trachypus humilis* Lindb. aus Japan äusserst nahe, welches aber dicht papillöse, undurchsichtige Blattzellen und fast faltenlose Blätter hat."

The differences between *T. massarti* and *T. humilis* mentioned by Fleischer are not stable ones and not essential.

4. Mitten mentions the name *Meteorium humilis* Mitt. as a synonym of *Trachypus humilis* Lindb., Trans. Linn. Soc. Bot. 2, 3(1891)173. This is however an error. The plant, wrongly identified as *Meteorium humile* (= *Trachypus humilis*) by Mitten, was actually the species *Thuidium mittenii* Broth., afterwards described for the first time by Brotherus, Hedwigia 38(1899)246. In 1912 Cardot transferred this species to the new genus *Boulaya* as *B. mittenii* (Broth.) Card., Rev. Bryol. 39(1912)2.

4b. Trachypus humilis Lindb. var. **tenerrimus** (Herz.) Zant. comb. nov. — Plate III, Map 3.

Trachypus tenerrimus Broth. ex Herz.: Herzog, Hedwigia 50(1910)135; Dixon, J. of Bot. 53(1915)290; Brotherus, Nat. Pfl. ed. 2, 11(1925)119; Bruehl, Rec. Bot. Surv. India 13, 1(1931)67.

Trachypus mauiensis Broth. ex Broth. syn nov.: Brotherus, Bish. Mus. Bull. 40(1927)20 (erroneously as Trachypodopsis); Bartram, Bish. Mus. Bull. 101(1933)163.

Papillaria mauiensis Broth. nom. nud.: Brotherus, Bull. Soc. Bot. Ital. 1904(1904)21.

Trachypus tenerrimus Herz. var. *flagelliferus* Broth. ex Herz. syn. nov.: Herzog, Hedwigia 50(1910)136.

Trachypus humilis Lindb. var. *gracilis* Nog. syn. nov.: Noguchi, J. Hattori Bot. Lab. (= J. Hattori Shokub. Kenk.) 2(1947)55; Sakurai, Musc. Jap. (1954)101.

Claopodium laevicaule Broth. nom. nud.: Bartram, Bish. Mus. Bull. 101(1933)163.

Type specimens: *Trachypus tenerrimus* Herz.: Ceylon, Nuwara Eliya, leg. Herzog, 1-1906, No. 140; type in L. — *Trachypus mauiensis* Broth.: Hawaiian Islands, Maui, leg. Baldwin, 12-1875, No. 204; holotype in H. — *Trachypus tenerrimus* Herz. var. *flagelliferus* Herz.: Ceylon, Horton Plaines, leg. Herzog, 2-1906, No. 140a; type in H. — *Trachypus humilis* Lindb. var. *gracilis* Nog.: Japan, Kiushiu, Kumamoto, Mt. Shiraga, leg. Noguchi, 31-7-1931, No. 7844; type in herb. Noguchi.

Very slender plants, often for the greater part consisting of *flagelliform branches,* which break off easily. Branches mostly attenuate, *not hamate.* Branch leaves up to *1 mm* long.

Sporophyte not known.

INDIA: Madura: Tiger Shola near Shembaganur, leg. Foreau, 15-1-1912, No. 140 (PC, T. massarti); Palni Hills, Kodaikanal, leg. Foreau, 1912, No. 212 (GRO, T. massarti).

CEYLON: Nuwara Eliya, leg. Herzog, 1-1906, No. 140 (L, T. tenerrimus, type); Horton Plaines, leg. Herzog, 2-1906, No. 140a (H, T. tenerrimus var. flagelliferus, type).

CHINA: Prov. of Kwei-Chow, near Lungtsu, leg. Handel-Mazzetti, 7-7-1917, No. 10581 (H. T. humilis).

KOREA: Isle of Quelpart ?; Mt. Hallasan, leg. Taquet, 12-1909, No. 142, PC, T. humilis var. brevifolius).

JAPAN: Kiushiu, Kumamoto, Mt. Shiraga, leg. Noguchi, 31-7-1931, No. 7844 (herb. Noguchi, T. humilis var. gracilis, isotype).

HAWAIIAN ISLANDS: Maui: leg. Baldwin, 12-1875, No. 204 (H, T. mauiensis, holotype). — Kauai: leg. Degener and Greenwell, 7-1-1952, No. 21613, ex herb. Schallert (GRO).

Distribution: Southern India (Madura); Ceylon; Kwei-Chow; Korea (Isle of Quelpart?); Kiushiu; Hawaiian Islands.

Ecology: On rocks, trees or decayed wood, from low altitudes up to 2100 m.

Note. This variety is closely allied to var. *humilis,* but is distinguished in being slenderer and having numerous flagelliform branches. The branches are hamate at tips.

There occur some intermediate forms with var. *humilis*, but the two varieties are in general clearly recognizable.

The variability in the colour, the aspect and shape of the leaves, and in the shape of the leaf cells is about the same as in var. *humilis.*

5. **Trachypus longifolius** Nog. — Plate II, Fig. 5. Plate III, Map 3.

Noguchi, J. Hattori Bot. Lab. (= J. Hattori Shokub. Kenk.) 2(1947)55.

Type specimen: Formosa, Prov. of Tainan, Mt. Niitaka (Morrison), leg. Ozaki, 20-8-1932, No. 8487; holotype in herb. Noguchi.

Slender, brownish-green, dull plants. Stems pinnately branched, hanging down?, more or less densely foliate all around stem, up to 5 cm long, with *numerous long, flagelliform,* more or less laxly foliate branches. Middle and upper stem leaves and branch leaves from an ovate, not auriculate base gradually, *narrowly and very long-acuminate,* often ending in a hyaline, sometimes somewhat flexuose hairpoint, slightly longitudinally plicate, up to *1.8 mm* long; leaf margin faintly denticulate, often somewhat recurved, faintly crenulate; leaf rib *faint,* ending *in or below midleaf.* Lower stem leaves from a broadly ovate, not auriculate base, abruptly rather long-acuminate; leaf margin very faintly denticulate; leaf rib absent. Lower leaves gradually passing into the middle and upper stem leaves. Leaf cells elongate to linear, about 3—10 times as long as wide; border cells not differentiated; alar cells few, quadrate to rectangular;

cell walls incrassate, strongly crenulate by numerous papillae; basal cells, especially those near the rib more *pellucid* than the other cells and with smooth cell walls; cell walls of the alar cells faintly crenulate.

Sporophyte not known.

FORMOSA: Prov. of Tainan, Mt. Niitaka (Morrison), leg. Ozaki, 20-8-1932, No. 8487 (herb. Noguchi, isotype).

Distribution: Formosa only.

Ecology: No data.

Note. This species is allied to *T. humilis* Lindb., but is clearly differentiated by the following characters:

a. numerous long, flagelliform branches occur (the flagelliform branches in *T. humilis*, if present, are mostly rather short and easily breaking off),
b. branches attenuate, never hamate by crowded apical leaves,
c. leaves very long- and narrowly acuminate,
d. leaf cells mostly somewhat more elongate.

2. **Trachypodopsis** Fleisch.

Fleischer, Hedwigia 45(1905)64; Brotherus, Nat. Pfl. 1, 3(1906)830; Fleischer, Musci Fl. Buitenzorg 3(1908)729; Brotherus, Nat. Pfl. ed. 2, 11(1925)120; Bartram, Philipp. J. Sc. 68(1939)196.

Dioicous; moderately slender to fairly robust, greenish, yellowish, in herb. often brownish, *never blackish* plants in dull or somewhat glossy, lax to rather dense mats, or hanging down. Primary stems creeping, with tufts of blackish rhizoids and more or less scale-like lower leaves. Secondary stems from 2 up to 30 cm long, procumbent or hanging down, mostly rather remotely, irregularly pinnately, occasionally dichotomously branched. Central strand present or wanting, but never well developed. Secondary stems and branches densely or laxly, either complanately foliate or not. Leaves appressed to horizontally spreading when dry, spreading to horizontally spreading when moist, from 1 up to 7 mm long, occasionally very distinctly falcate-second (and then mostly asymmetrical) or in longitudinal rows, plane to very strongly longitudinally plicate, often crisped near apex, from an ovate or broadly ovate, *faintly to strongly auriculate* base gradually or somewhat abruptly, rather short- to very long-acuminate; leaf margin rather faintly to strongly serrate or toothed; teeth themselves occasionally finely denticulate. Auricles small to very large and shaped like a snail-shell. Branch leaves sometimes somewhat shorter acuminate than the stem leaves. Leaf rib single, ending below apex. Leaf cells almost isodiametric to linear (1—10 times as long as wide), on both sides *unipapillate over lumen or smooth*; border cells either more elongate and forming a leaf border or not; cells towards base more elongate, smooth; cells in the auricles mostly quadrate to rectangular, smooth; alar cells mostly present, occasionally large, quadrate to rectangular; cell walls mostly somewhat incrassate and pitted.

Sporophyte lateral on the secondary stems and (rarely) on the branches. Male gametoecia bud-shaped, with few antheridia and paraphyses; outer perigamial leaves small, short-acuminate, inner perigamial leaves somewhat larger, rather abruptly ending in a narrow point, both of them without rib, entire; antheridia club-shaped, reddish. Female gametoecia bud-shaped with a number of archegonia and paraphyses; female perigamial leaves like the male perigamial leaves, but the inner ones ending in a rather long and narrow, somewhat denticulate point; archegonia bottle-shaped, long-necked, reddish. Seta up to *18 mm* long, erect, *papillose,* brownish, contorted when dry. Vaginula cylindrical, smooth, with a number of archegonia and numerous rather long paraphyses. Perichaetial leaves pale, the outer leaves rather small, short-acuminate, faintly denticulate, without rib, the inner ones large, long- and narrowly acuminate, faintly denticulate, rib present; cells elongate, smooth; cell walls incrassate, pitted. *Capsule erect, subglobular to ovoid,* up to 3 mm long, brownish, with a short neck; exothecium cells quadrate or hexagonal to rectangular, in longitudinal rows, smaller towards mouth; cell walls somewhat incrassate. Lid conical, obliquely rostrate. Peristome double. Exostome teeth 16, on a low basal membrane, lanceolate-subulate, yellowish, with a median line, trabeculate, papillose at base, strongly papillose towards the ends. Endostome teeth 16, on a low basal membrane, somewhat shorter than the exostome teeth, narrowly lanceolate, hyaline, papillose, often carinate and perforated along the median line. *Cilia absent.* Calyptra small, *cucullate,* naked or with a few hairs (not seen). Spores medium sized, up to 25 μ in diameter, subglobular, strongly papillose, yellowish.

History of the genus up to the present paper.

The genus *Trachypodopsis* Fleisch. was described for the first time by Fleischer in 1905, Hedwigia 45(1905)64, with 20 species, which before mostly belonged to the genus *Trachypus* Reinw. et Hornsch. These 20 species were:

T. rugosa (Lindb.) Fleisch.
T. rigida (Bosch et Lac.) Fleisch.
T. declinata (Mitt.) Fleisch.
T. crispatula (Hook.) Fleisch.
T. subcrispatula (C. Muell.) Fleisch. nom. nud.
T. macrodontis Fleisch.
T. serrulata (P. Beauv.) Fleisch.
T. pintasiana (C. Muell.) Fleisch. nom. nud. (= ? *T. quintasiana* (C. Muell.) Fleisch. nom. nud.)
T. sumatrana (C. Muell.) Fleisch. nom. nud.
T. auriculata (Mitt.) Fleisch.
T. himantophylla (Ren. et Card.) Fleisch.
T. lacridens (C. Muell.) Fleisch. nom. nud.
T. feae (C. Muell.) Fleisch. nom. nud.
T. bohnhofii (C. Muell.) Fleisch. nom. nud.
T. flaccida (Card.) Fleisch.
T. craspedophylla (C. Muell.) Fleisch. nom. nud.
T. rutenbergii (C. Muell.) Fleisch.
T. eriocladioides (C. Muell.) Fleisch. nom. nud.

T. normandi (Broth. et Par.) Fleisch.
T. ornans (Reich.) Fleisch.

The species *T. nodicaulis* (C. Muell.) Fleisch., according to Fleischer, Hedwigia 45(1906)67, is conspecific with *T. serrulata* (P. Beauv.) Fleisch.

Among these 20 species there are 8 nomina nuda and 2 species have been transferred by Fleischer, Musci Fl. Buitenzorg 3(1908)727, to the new genus *Neolindbergia* Fleisch., namely *T. rugosa* (Lindb.) Fleisch. and *T. rigida* (Bosch et Lac.) Fleisch.

According to Brotherus, Nat. Pfl. 1, 3(1906)832, the species *T. rutenbergii* (C. Muell.) Fleisch., *T. nodicaulis* (C. Muell.) Fleisch. and *T. quintasiana* (C. Muell.) Fleisch. nom. nud. are not specifically different from *T. serrulata* (P. Beauv.) Fleisch. There thus remain 9 validly published species, namely:

T. declinata (Mitt.) Fleisch.
T. crispatula (Hook.) Fleisch.
T. macrodon Fleisch. (before erroneously cited by Fleischer as *T. macrodontis* Fleisch.).
T. serrulata (P. Beauv.) Fleisch.
T. auriculata (Mitt.) Fleisch.
T. himantophylla (Ren. et Card.) Fleisch.
T. flaccida (Card.) Fleisch.
T. normandi (Broth. et Par.) Fleisch.
T. ornans (Reich.) Fleisch.

The following species, subspecies and varieties have successively been added to the genus:

T. laxoalaris Broth.	Wiss. Erg. Deut. Zentr. Afr. Exp. 2, 1(1910)160.
T. otiophylla (Card.) Card.	Rev. Bryol. 38(1911)39.
T. densifolia Broth.	Symb. Sin. 4(1929)77.
T. crispatula (Hook.) Fleisch. ssp. *longifolia* Reim.	Hedwigia 71(1931)56.
T. plicata Dix.	Ann. Bryol. 9(1936)65.
T. angustiretis Dix.	Ann. Bryol. 12(1939)53.
T. crispatula (Hook.) Fleisch. var. *longifolia* Nog.	J. Sc. Hiroshima Univ. B, 2, 3(1939) 214.
T. formosana Nog.	J. Hattori Bot. Lab. (= J. Hattori Shokub. Kenk.) 2(1947)59.
T. tereticaulis Froehl.	Ann. Naturh. Mus. Wien 59(1953)90.
T. subulata Chen	Fedd. Rep. 58(1955)29.

In 1931, Hedwigia 71(1931)56, Reimers transferred the species *T. macrodon* Fleisch. to *T. crispatula* (Hook.) Fleisch. as *T. crispatula* ssp. *macrodon* (Fleisch.) Reim. and he divided *T. crispatula* into 3 subspecies *viz.* the above mentioned ssp. *macrodon* and ssp. *longifolia* Reim. and *eucrispatula* Reim.

When Fleischer described the genus *Trachypodopsis* he did not indicate a type species. I propose the species *Trachypodopsis serrulata* (P. Beauv.) Fleisch. as the lectotype of the genus.

Relationships.

Fleischer, Hedwigia 45(1905)64; Fleischer, Musci Fl. Buitenzorg 3 (1908)730; ibid. 4(1923)1495.

The genus *Trachypodopsis* is in general easily distinguishable from the other genera. There are some arguments that the genus might be related to the *Meteoriaceae. T. serrulata* (P. Beauv.) Fleisch. and *T. auriculata* (Mitt.) Fleisch. for instance have sometimes got the same hanging habit, which is characteristic for most *Meteoriaceae*. The shape of the leaf auricles too is the same as it is in many species of that family. Moreover the sporophyte resembles some *Meteoriaceae, e. g.* many species of the genus *Papillaria* in having a short seta, ovoid capsule, low basal membrane of the endostome with narrowly lanceolate teeth and in the absence of cilia.

The gametophyte of *Trachypodopsis* bears close resemblance to that of the genus *Duthiella* (for the differences with this genus see *Duthiella*, relationships).

All *Trachypodopsis* species used, before 1905, to be incorporated within the genus *Trachypus*, which genus is however clearly distinguished in having many papillae *on the cell walls*, as contrasted with *Trachypodopsis* where only one papilla occurs over the lumina of the leaf cells, or the leaf cells are smooth.

Relationships within the genus.

All *Trachypodopsis* species are rather closely allied. The most variable, and at the same time most wide-spread species is *T. serrulata* (P. Beauv.) Fleisch.

T. auriculata (Mitt.) Fleisch. differs from *T. serrulata* mainly in having very large, snail-shell shaped auricles and smooth leaf cells.

T. formosana Nog. stands somewhat between these two species in having large, snail-shell shaped auricles and part of the leaf cells papillose.

T. laxoalaris Broth. is very closely allied to *T. serrulata* and differs only in having numerous large alar cells.

T. normandi (Broth. et Par.) Fleisch. differs in having small, faintly auriculate leaves and aberrant alar cells.

The sporophytes, of which only those of *T. serrulata* and *T. auriculata* are known, are almost identical. *T. auriculata* has only got a somewhat longer seta and a slightly larger capsule.

Excluded species.

Trachypodopsis declinata (Mitt.) Fleisch. has been transferred to the genus *Duthiella* as **D. declinata** (Mitt.) Zant.

Trachypodopsis tereticaulis Froehl.
= **Diaphanodon blandus** (Harv.) Ren. et Card.

Trachypodopsis warburgii Broth. nom. nud.
= **Aërobryopsis longissima** (Doz. et Molk.) Fleisch.

Geographical distribution.

Herzog, Geogr. Moose (1926) 143, 268, 306, 340, 343, 346, 389.

The genus *Trachypodopsis* is found in South-East Asia, South and Central Africa, Central America and in the Hawaiian Islands.

Trachypodopsis serrulata (P. Beauv.) Fleisch.: all regions mentioned with the exception of the Hawaiian Islands. Very abundant in South-East Asia, in the other regions found less frequently.

Trachypodopsis auriculata (Mitt.) Fleisch.: Himalaya, Yuennan, Ceylon, Formosa and the Hawaiian Islands.

Trachypodopsis formosana Nog.: Formosa.

Trachypodopsis laxoalaris Broth.: Ruwenzori.

Trachypodopsis normandi (Broth. et Par.) Fleisch.: French Guinea, Sierra Leone.

Ecology.

Mostly on trees, sometimes on calcareous rocks, sandstone etc. or growing terrestrial, from low altitudes up to 3500 m.

Trachypodopsis serrulata (P. Beauv.) Fleisch. is one of the most important mosses of the mass vegetation in the mountain forests of South-East Asia (Herzog, Geogr. Moose (1926)143).

Note. It was impossible for me to get any material of one of the following nomina nuda from herb. C. Mueller, mentioned by Fleischer, Hedwigia 61(1920)404:

Trachypodopsis bohnhofii (C. Muell.) Fleisch. nom. nud.,
Trachypodopsis lacridens (C. Muell.) Fleisch. nom. nud.,
Trachypodopsis cavernosa (C. Muell.) Fleisch. nom. nud.

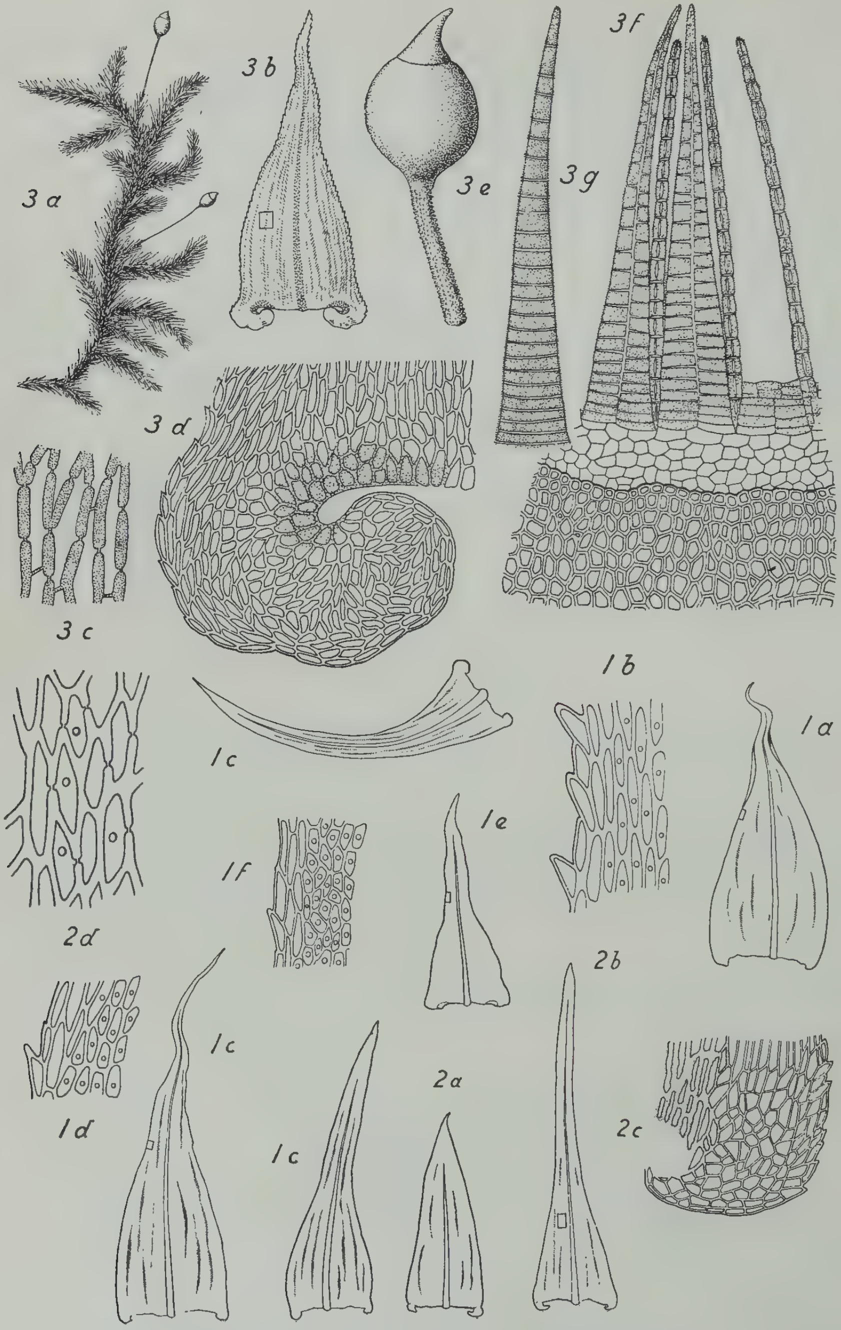
Key to the species

1. Plants fairly robust; auricles large to very large, shaped like a snail-shell (sometimes breaking off easily); leaves strongly longitudinally plicate.
    2. All leaf cells smooth; leaves long-acuminate; auricles very large . . . 3. **T. auriculata** (Mitt.) Fleisch.
    2. Part of the leaf cells unipapillate over lumen, the others smooth; leaves very long-acuminate; auricles large . . . . 2. **T. formosana** Nog.
1. Plants moderately slender to fairly robust; auricles small to rather large, not or faintly shaped like a snail-shell; leaves plane or longitudinally plicate; all leaf cells (except the border cells and the basal cells) unipapillate over lumen.
    3. Alar cells hardly developed to more or less distinct, but never large and numerous . . . . 1. **T. serrulata** (P. Beauv.) Fleisch.
    3. Alar cells large.
        4. Alar cells 5—10, abruptly passing into the other leaf cells; leaf border more or less distinct; leaves up to 1.5 mm long . . . 5. **T. normandi** (Broth. et Par.) Fleisch.
        4. Alar cells numerous, more or less gradually passing into the other leaf cells; leaf border absent; leaves up to 3.5 mm long 4. **T. laxoalaris** Broth.

1. Trachypodopsis serrulata (P. Beauv.) Fleisch.

For literature and type specimens see below.

Dioicous; moderately slender to fairly robust, greenish, in herb. often brownish, never blackish plants in dull or somewhat glossy, dense to lax mats or hanging down. Secondary stems from 2 up to *25 cm* long, procumbent or hanging down, irregularly pinnately branched, occasionally dichotomously or somewhat arborescently branched. Secondary stems and branches densely or laxly, often somewhat complanately foliate. Leaves appressed to horizontally spreading when dry, spreading to horizontally spreading when moist, up to *4 mm* long, occasionally very distinctly falcate-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second (and then mostly asymmetrical) or in longitudinal rows, plane to very strongly longitudinally plicate, mostly more or less crisped near apex, from an ovate or broadly ovate, more or less auriculate base gradually or somewhat abruptly *rather short to very long- and narrowly acuminate*; leaf margin rather faintly to strongly serrate or toothed, teeth themselves sometimes finely denticulate. *Auricles small to rather large,* sometimes faintly shaped like a snail-shell. Branch leaves sometimes somewhat shorter acuminate and with smaller auricles than the stem leaves. Leaves of the lower parts of the secondary stems mostly shorter acuminate. Leaf rib single, ending below apex. Leaf cells subisodiametric to linear (1—10 times as long as wide), on both sides *unipapillate* over lumen; border cells either more elongate and forming a leaf border or not, smooth, cells towards base more elongate, smooth, cells in the auricles quadrate to rectangular, smooth; alar cells *hardly developed to more or less distinct,* but never large and numerous, quadrate to rectangular; cell walls mostly somewhat incrassate, pitted.

Sporophyte as in the diagnosis of the genus. Seta up to *8 mm* long and capsule up to *2.5 mm.*

An exceedingly variable species with 3 varieties which may be distinguished by the following key:

1. Moderately slender to medium-sized plants; stems 1—4 cm long; leaf border distinct; median leaf cells 1—3 times as long as wide
1c. var. **guilbertii** (Thér. et P. Vard.) Zant.

1. Medium sized to fairly robust plants; stems up to 25 cm long; leaf border either differentiated or not; median leaf cells 2—10 times as long as wide.
    2. Auricles distinct, often more or less protruding; leaves mostly long-acuminate, mostly strongly longitudinally plicate; leaf border more or less distinct
    1b. var. **crispatula** (Hook.) Zant.
    2. Auricles small to fairly small, never protruding; leaves rather short- to rather long-acuminate, not or faintly longitudinally plicate; leaf border absent
    1a. var. **serrulata**

There occur many intermediate forms.

1a. Trachypodopsis serrulata (P. Beauv.) Fleisch. var. **serrulata.** — Plate IV, Fig. 1a and 1b. Plate V, Map 1.

Trachypodopsis serrulata (P. Beauv.) Fleisch., Hedwigia 45(1906)67; Brotherus, Nat. Pfl. 1, 3(1906)831; Fleischer, Musci Fl. Buitenzorg 3(1908) 734; Dixon, S. Afr. J. Sc. 18(1922)325; Potier de la Varde, Bull. Soc. Bot. France 71(1924)1058; Brotherus, Nat. Pfl. ed. 2, 11(1925)122; Sim, Trans. Roy. Soc. S. Afr. 15(1926)397; Potier de la Varde, Bull. Mus. Hist. Nat. 15, 2, 3(1943)129; Demaret, Bull. Jard. Bot. Et. Bruxelles 18, 1 (1946)40; Potier de la Varde, Ark. Bot. 2, 3, 8(1955)178; Potier de la

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Plate IV. — Fig. 1a, b: *Trachypodopsis serrulata* (P. Beauv.) Fleisch. var. *serrulata,* 1a leaf (12/1), 1b leaf cells (150/1); Fig. 1c, d: var. *crispatula* (Hook.) Zant., 1c leaves (12/1), 1d leaf cells (150/1); Fig. 1e, f: var. *guilbertii* (Thér. et P. Vard.) Zant., 1e leaf (12/1), 1f leaf cells (150/1); Fig. 2: *Trachypodopsis formosana* Nog., 2a lower stem leaf (12/1), 2b upper stem or branch leaf (12/1), 2c auricle (150/1), 2d leaf cells (300/1); Fig. 3: *Trachypodopsis auriculata* (Mitt.) Fleisch., 3a habit (1/1), 3b leaf (12/1), 3c leaf cells (300/1), 3d auricle (150/1), 3e capsule (8/1), 3f peristome (125/1), 3g exostome tooth, inner face (125/1). (Fig. 1 and 2 original, Fig. 3 after Brotherus, Nat. Pfl. ed. 2, 11(1925)121).

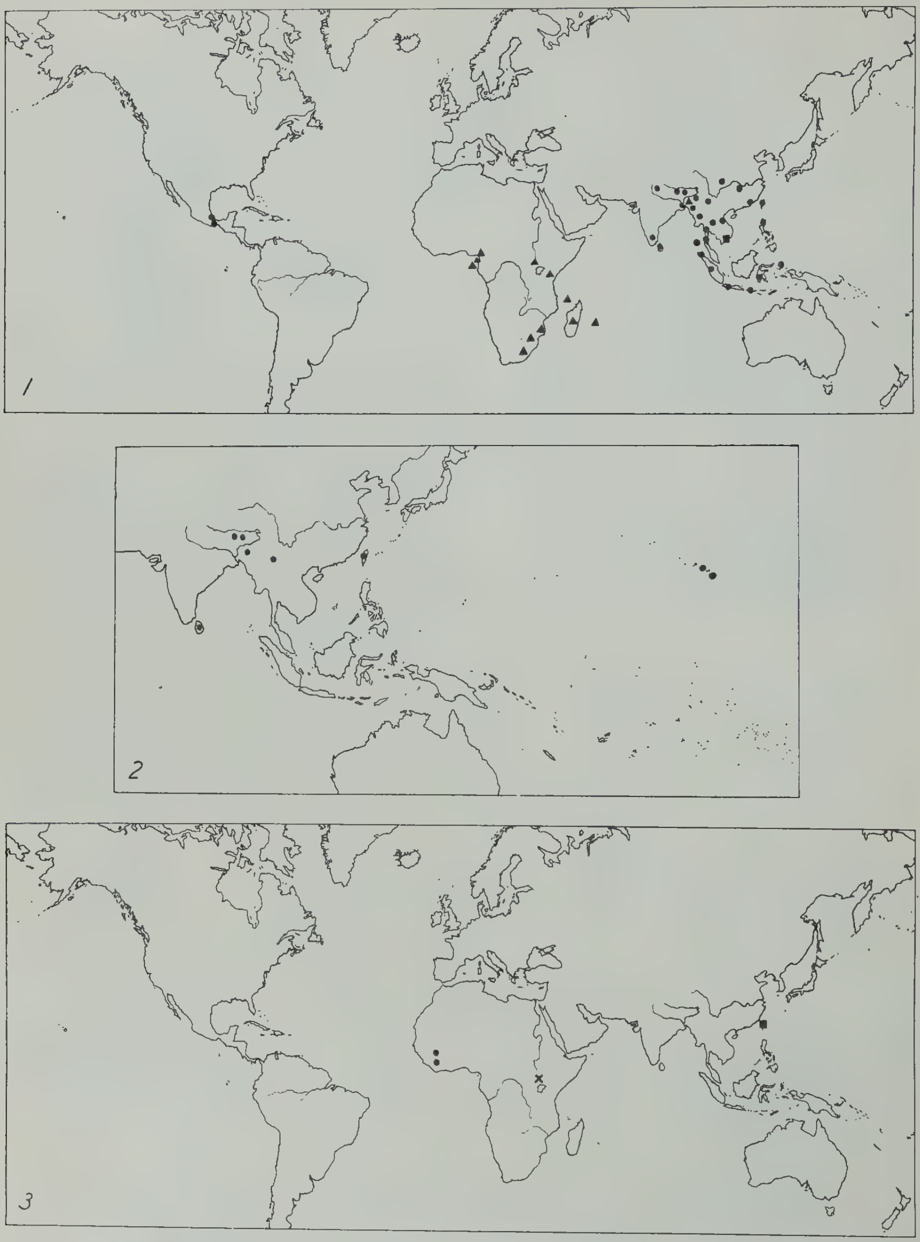

Plate V. — Map 1: Area of *Trachypodopsis serrulata* (P. Beauv.) Fleisch. var. *serrulata* (▲), var. *crispatula* (Hook.) Zant. (●) and var. *guilbertii* (Thér. et P. Vard.) Zant. (■); Map 2: Area of *Trachypodopsis auriculata* (Mitt.) Fleisch.; Map 3: Area of *Trachypodopsis formosana* Nog. (■), *Trachypodopsis laxoalaris* Broth. (✕) and of *Trachypodopsis normandi* (Broth. et Par.) Fleisch. (●).

Varde, Mém. Inst. Sc. Madagascar B, 6(1955)216.

Pilotrichum ? serrulatum P. Beauv., Prodr. (1805)83 (not seen).

Neckera serrulata (P. Beauv.) Brid., Spec. Musc. 2(1812)29; Schwaegrichen, Spec. Musc. Suppl. 1, 2(1816)148; Bridel, Mant. Musc. (1819)138; Bridel, Bryol. Univ. 2(1827)237; C. Mueller, Syn. 2(1851)140.

Meteorium serrulatum (P. Beauv.) Mitt., J. Linn. Soc. Bot. 7(1863)156.

Papillaria serrulata (P. Beauv.) Jaeg., Ber. S. Gall. Naturw. Ges. 1875/76(1877)274 = Ad. 2(1877)178.

Trachypus serrulatus (P. Beauv.) Besch., Ann. Sc. Nat. Bot. 6, 10(1880) 269; Mitten, J. Linn. Soc. Bot. 22(1887)314; Paris, Ind. Bryol. (1898)1303; ibid. ed. 2, 5(1906)64; Wager, Check List Moss. S. Afr. (1917)13 (as T. serratulus P. Beauv.).

Neckera nodicaulis C. Muell., Linn. 40(1876)269.

Papillaria nodicaulis (C. Muell.) Jaeg., Ber. S. Gall. Naturw. Ges. 1875/76(1877)274 = Ad. 2(1877)178.

Trachypus nodicaulis (C. Muell.) Besch., Ann. Sc. Nat. Bot. 6, 10(1880) 270; Paris, Ind. Bryol. (1898)1303; ibid. ed. 2, 5(1906)64.

Trachypodopsis nodicaulis (C. Muell.) Fleisch., Hedwigia 45(1906)67; Brotherus, Nat. Pfl. 1, 3(1906)832; Fleischer, Hedwigia 61(1920)404; Brotherus, Nat. Pfl. ed. 2, 11(1925)122.

Trachypus rutenbergii C. Muell. in C. Muell. et Geh.: C. Mueller, Abh. Naturw. Ver. Bremen 7, 2(1881)209; Paris, Ind. Bryol. (1898)1303; ibid. ed. 2, 5(1906)64.

Trachypodopsis rutenbergii (C. Muell.) Fleisch., Hedwigia 45(1908)68; Brotherus, Nat. Pfl. 1, 3(1906)832; Fleischer, Hedwigia 61(1920)404; Brotherus, Nat. Pfl. ed. 2, 11(1925)122.

Papillaria rutenbergii (C. Muell.) Par., Ind. Bryol. (1897)908; ibid. ed. 2, 3(1905)359.

Hypnum ericetorum Brid., Spec. Musc. 2(1812)97; Schwaegrichen, Spec. Musc. Suppl. 1, 2(1816)148; Bridel, Mant. Musc. (1819)138. (fid. Bridel and Schwaegrichen).

Papillaria pintasiana C. Muell. nom. nud.: Fleischer, Hedwigia 45 (1906)67.

Trachypus pintasianus (C. Muell.) C. Muell. nom. nud.: Fleischer, Hedwigia 61(1920)404.

Trachypodopsis pintasianus (C. Muell.) Fleisch. nom. nud. = ? T. quintasiana (C. Muell.) Fleisch.: Fleischer, Hedwigia 45(1906)67; Brotherus, Nat. Pfl. 1, 3(1906)832; Fleischer, Hedwigia 61(1920)404; Brotherus, Nat. Pfl. ed. 2, 11(1925)122.

Neckera macleana Rehm. nom. nud.: Paris, Ind. Bryol. (1897)852; Wager, Check List Moss. S. Afr. (1917)13; Dixon and Gepp, Kew Bull. 1923(1923)230; Sim, Trans. Roy. Soc. S. Afr. 15(1926)397.

Type specimens: *Trachypodopsis serrulata* (P. Beauv.) Fleisch.: Mascarene Islands, Bourbon, leg. Bory St. Vincent; isotype in L, No. 910.120—212. — *Trachypodopsis nodicaulis* (C. Muell.) Fleisch.: Comoro Islands, Johanna, leg. Hildebrandt, June—Aug. 1875, No. 1833; type probably lost. — *Trachypodopsis rutenbergii* (C. Muell.) Fleisch.: Madagascar, Ambatondrazaka, leg. Rutenberg, 6-12-1877; type probably lost.

Medium sized to fairly robust plants in dull or somewhat glossy, lax or more or less dense mats. Secondary stems up to *15 cm* long, procumbent, more or less irregularly, mostly rather remotely branched. Leaves spreading to horizontally spreading when dry, up to *3 mm* long, *plane to faintly longitudinally plicate,* mostly crisped near apex, from an ovate or broadly ovate, mostly *faintly auriculate* base *rather short- to rather long-acuminate.* Auricles *small to fairly small,* not protruding. Leaf cells *4—10* times as long as wide, border cells *not differentiated.*

Sporophyte not known.

MASCARENE ISLANDS: Bourbon: leg. Bory St. Vincent (L, No. 910.120—212, isotype and No. 910.120—213); leg. Rodriguez (PC); ex herb. Montagne, 1839 (L).

MADAGASCAR: Mt. Ankaratra, leg. Borgen, 1877-79, No. 37 (L); Imorina orient, Andrangotoaka, leg. Hildebrandt, 2-1880 (H, T. rutenbergii).

COMORO ISLANDS: Great Comoro: leg. Macé, 1900 (H); leg. Humblot, No. 1528 (H, T. nodicaulis).

TRANSVAAL: Mt. supra Lydenburg, leg. MacLea, No. 616 (H, Neckera macleana).

NIGERIA: Cameroon Mountains, leg. Jungner, 6-1891, No. 157 (H, T. quintasi).

INDIA: Assam: Manipur, leg. Fraser, 1899 (H, T. auriculatus).

Distribution: *Africa:* Mascarene Islands, Madagascar, Comoro Islands, Gazaland, Transvaal, Southern Rhodesia, Kilimanjaro, Ruwenzori, Ruanda-Urundi, Cameroon Mountains (Nigeria), Fernando Po, St. Thomas. *Asia:* Assam.

Intermediate forms with var. *crispatula* (Hook.) Zant. occur in South-East Asia.

Ecology: On trees in the rain forest from 1300 up to 2300 m altitude.

Notes. 1. This variety is somewhat variable, but much less so than the following one from which it is mainly distinguished by the following characters:

a. leaves not or faintly longitudinally plicate, mostly rather strongly crisped near apex, never appressed and shorter acuminate,

b. auricles mostly smaller, not protruding,

c. leaf cells mostly slightly more elongate, border cells not differentiated.

There occur however intermediate forms with var. *crispatula* (Hook.) Zant., especially in South-East Asia, *e.g.* in the Himalaya, Ceylon, Java and Luzon, but in my opinion all these plants are closer related to var. *crispatula* than to var. *serrulata.*

2. Some specimens from Africa are distinguished in having laxly foliate stems and branches and a less crisped leaf apex. These plants were described by C. Mueller as the new species *Neckera nodicaulis* C. Muell. (l. c. 1876). About this species he says: "Ich hätte diese neue Art am liebsten zu dem Mascarenen Moose gezogen, wenn die angegebenen Unterschiede nicht constant aufträten." However intermediates do occur, *e.g.* the specimens identified as *Trachypus rutenbergii* C. Muell. and as *Trachypus pintasianus* (C. Muell.) C. Muell. nom. nud. According to Brotherus (l. c. 1906 and 1925) the three species mentioned are hardly specifically different from *Trachypodopsis serrulata* (P. Beauv.) Fleisch., which is in accordance with my opinion.

3. The specimen from Assam, Manipur differs from the typical form of var. *serrulata* in having a less strongly serrate leaf margin and larger

auricles, which are faintly shaped like a snail-shell, the reason why this specimen was originally identified as *T. auriculata* (Mitt.) Fleisch., but the latter has even larger auricles. Moreover the habit of the specimen from Manipur is exactly the same as in var. *serrulata*, the leaves are not longitudinally plicate and the leaf cells are distinctly papillate, as contrasted with *T. auriculata*.

4. *Trachypodopsis serrulata* (P. Beauv.) Fleisch. var. *serrulata* bears very close resemblance to *Duthiella speciosissima* Card. (when not in fruit) and these two species are undistinguishable with the naked eye. The microscopical differences with *D. speciosissima* are:

a. auricles slightly larger,
b. leaf cells somewhat more elongate,
c. cells walls more incrassate.

The sporophytes of the two genera are quite different; of var. *serrulata* however the sporophyte is not known and in my opinion it is not quite impossible that, when the sporophyte of this variety does become known it might be that these plants belong to the genus *Duthiella*. Notwithstanding its close resemblance to *Duthiella speciosissima* Card. it is much more likely though var. *serrulata* actually belongs to the genus *Trachypodopsis* for the following reasons:

a. its close resemblance to *Trachypodopsis serrulata* var. *crispatula* (Hook.) Zant. (the sporophyte of which is known) and the occurrence of intermediate forms,

b. the genus *Duthiella* is only found in South-East Asia.

5. In herb. L there are three specimens of *Trachypodopsis serrulata* (P. Beauv.) Fleisch. gathered by Bory St. Vincent in the isle of Bourbon (Mascarene Islands). The type specimen of *Pilotrichum serrulatum* P. Beauv. (= *T. serrulata*) of the herb. of Palisot de Beauvois has probably been lost, but one of the specimens in herb. L (No. 910.120—212) was originally identified as *Pilotrichum serrulatum* P. Beauv. and it is very likely that this specimen is an isotype of *P. serrulatum*. Whether the other two specimens of herb. L are also isotypes is impossible to ascertain.

The specimen from which Bridel described *Hypnum ericetorum* Brid. (l. c. 1812), also gathered by Bory St. Vincent in the isle of Bourbon (may be the same gathering as the type specimen of *Pilotrichum serrulatum* P. Beauv.), has probably been lost, but according to Schwaegrichen (l. c. 1816) and Bridel (l. c. 1819) this species is identical with *Neckera serrulata* (P. Beauv.) Brid. = *Trachypodopsis serrulata* (P. Beauv.) Fleisch.

1b. Trachypodopsis serrulata (P. Beauv.) Fleisch. var. **crispatula** (Hook.) Zant. comb. nov. — Plate IV, Fig. 1c and 1d. Plate V, Map 1.

Trachypodopsis crispatula (Hook.) Fleisch., Hedwigia 45(1906)65; Brotherus, Nat. Pfl. 1, 3(1906)831; Fleischer, Musci Fl. Buitenzorg 3(1908) 734; Brotherus, Philipp. J. Sc. 5, 2, C, Bot. (1910)154; Herzog, Hedwigia 50(1910)136; Brotherus, Philipp. J. Sc. 8, 2, C, Bot. (1913)79; Williams, Bull. New York Bot. Gard. 8, 31(1914)357; Dixon, Rec. Bot. Surv. India 6, 3(1914)64; Dixon, J. of Bot. 53(1915)290; Brotherus, Philipp. J. Sc. 13, 4, C, Bot. (1918)211; Fleischer, Hedwigia 61(1920)404; Potier de la Varde, Rev. Bryol. 50(1923)73; Brotherus, Nat. Pfl. ed. 2, 11(1925)121;

Brotherus, Symb. Sin. 4(1929)77; Reimers, Hedwigia 71(1931)56; Bruehl, Rec. Bot. Surv. India 13, 1(1931)68; Dixon, Hong Kong Nat. Suppl. 2 (1933)19; Dixon, J. Siam Soc. Nat. Hist. Suppl. 10, 1(1935)12; Noguchi, Trans. Nat. Hist. Soc. Formosa 25(1935) 63; Herzog, Ann. Bryol. 12(1939) 91; Noguchi, J. Sc. Hiroshima Univ. B, 2, 3(1939)214; Bartram, Philipp. J. Sc. 68(1939)196; Bartram, Farl. 1, 2(1943)180; Noguchi, J. Hattori Bot. Lab. (= J. Hattori Shokub. Kenk.) 2(1947)58; Froehlich, Ann. Naturh. Mus. Wien 59(1953)90; Bartram, Rev. Bryol. Lich. 23(1954)250; Bartram, Bull. Torr. Bot. Cl. 82, 1(1955)26.

Hypnum crispatulum Hook., Trans. Linn. Soc. London 9(1808)321; Schwaegrichen, Spec. Musc. Suppl. 1, 2(1816)302; Bridel, Mant. Musc. (1819)181.

Neckera crispatula (Hook.) Hook., Musci Exot. 2(1819) tab. 152; Bridel, Bryol. Univ. 2(1827)236; Schwaegrichen, Spec. Musc. Suppl. 3, 5(1827) tab. 229; C. Mueller, Syn. 2(1851)140.

Trachypus crispatulus (Hook.) Mitt., J. Linn. Soc. Bot. Suppl. 1(1859) 129; van den Bosch and van der Sande Lacoste, Bryol. Jav. 2(1864)99; Paris, Ind. Bryol. (1898)1302; Brotherus, Rec. Bot. Surv. India 1, 12(1899) 323; Cardot, Rev. Bryol. 28(1901)115; Paris, Ind. Bryol. ed. 2, 5(1906)63.

Papillaria crispatula (Hook.) Jaeg., Ber. S. Gall. Naturw. Ges. 1875/76 (1877)274 = Ad. 2(1877)178.

Cyrtopus crispatulus Brid., Bryol. Univ. 2(1827)237.

Trachypodopsis crispatula (Hook.) Fleisch. ssp. *eucrispatula* Reim. nom. illeg.: Reimers, Hedwigia 71(1931)56.

Trachypus himantophyllus C. Muell. ex Ren. et Card.: Paris, Ind. Bryol. (1898)1303 (as nom. nud.); ibid. Suppl. (1900)322; Renauld and Cardot, Bull. Soc. Roy. Bot. Belg. 38, 1(1900)22; ibid. 41, 1(1905)74; Paris, Ind. Bryol. ed. 2, 5(1906)63.

Trachypodopsis himantophylla (Ren. et Card.) Fleisch., Hedwigia 45 (1906)67; Brotherus, Nat. Pfl. 1, 3(1906)831; Fleischer, Hedwigia 61(1920) 404; Brotherus, Nat. Pfl. ed. 2, 11(1925)121; Reimers, Hedwigia 71(1931) 56; Bruehl, Rec. Bot. Surv. India 13, 1(1931)68; Dixon, J. Bombay Nat. Hist. Soc. 39(1937)781.

Trachypodopsis macrodon Fleisch. syn. nov.: Fleischer, Hedwigia 45 (1906)67 (erroneously named T. macrodon*tis* Fleisch., without description); Fleischer, Musci Fl. Buitenzorg 3(1908)733; Brotherus, Nat. Pfl. ed. 2, 11 (1925)121; Bruehl, Rec. Bot. Surv. India 13, 1(1931)68; Froehlich, Ann. Naturh. Mus. Wien 59(1953)90.

Trachypodopsis crispatula (Hook.) Fleisch. ssp. *macrodon* (Fleisch.) Reim. syn. nov.: Reimers, Hedwigia 71(1931)56.

Prionodon otiophyllus Card., Rev. Bryol. 37(1910)7.

Trachypodopsis otiophylla (Card.) Card., Rev. Bryol. 38(1911)39; Brotherus, Nat. Pfl. ed. 2, 11(1925)121; Bartram, Field. Bot. 25(1949)247.

Trachypodopsis densifolia Broth. syn. nov.: Brotherus, Symb. Sin. 4(1929)77.

Trachypodopsis plicata Dix. syn. nov.: Dixon, Ann. Bryol. 9(1936)65.

Trachypodopsis angustiretis Dix. syn. nov.: Dixon, Ann. Bryol. 12 (1939)53.

Trachypodopsis subulata Chen syn. nov.: Chen, Fedd. Rep. 58(1955)29.

Trachypodopsis crispatula (Hook.) Fleisch. ssp. *longifolia* Reim. syn. nov.: Reimers, Hedwigia 71(1931)56.

Trachypodopsis crispatula (Hook.) Fleisch. var. *longifolia* Nog. homonym illeg.: Noguchi, J. Sc. Hiroshima Univ. B, 2, 3(1939)214; Noguchi, J. Hattori Bot. Lab. (= J. Hattori Shokub. Kenk.) 2(1947)58.

Trachypus crispatulus (Hook.) Mitt. f. *gracilior* Mitt. nom. nud.: Mitten, J. Linn. Soc. Bot. Suppl. 1(1859)129.

Trachypus subcrispatulus C. Muell. nom. nud.: Fleischer, Hedwigia 45 (1906)67; ibid. 61(1920)404.

Trachypodopsis subcrispatula (C. Muell.) Fleisch. nom. nud.: Fleischer, Hedwigia 45(1906)67; ibid. 61(1920)404.

Papillaria feae C. Muell. nom. nud.: Paris, Ind. Bryol. (1897)904.

Trachypus feae (C. Muell.)? nom. nud.: C. Mueller, Nuov. Giorn. Bot. Ital. 1891(1891)601; Fleischer, Hedwigia 45(1906)67; ibid. 61(1920)404.

Trachypodopsis feae (C. Muell.) Fleisch. nom. nud.: Fleischer, Hedwigia 45(1906)67; ibid. 61(1920)404.

Trachypus sumatranus C. Muell. nom. nud.: Fleischer, Hedwigia 45 (1906)67; ibid. 61(1920)404.

Trachypodopsis sumatrana (C. Muell.) Fleisch. nom. nud.: Fleischer, Hedwigia 45(1906)67; ibid. 61(1920)404.

Type specimens: *Trachypodopsis crispatula* (Hook.) Fleisch.: Nepal, leg. Buchanan; holotype in K. — *Trachypodopsis himantophylla* (Ren. et Card.) Fleisch.: Sikkim, Darjeeling, leg. Determes 1896; isolectotype in PC. — *Trachypodopsis macrodon* Fleisch.: Java, Tjibeurum, leg. Fleischer, 9-1902; lectoholotype in FH. — *Trachypodopsis otiophylla* (Card.) Card.: Mexico, Morelos, Cuernavaca, leg. Pringle, 1908, No. 15184; type not seen. — *Trachypodopsis densifolia* Broth.: China, Yuennan, leg. Handel-Mazzetti, 28-5-1915, No. 6116; type probably lost. — *Trachypodopsis plicata* Dix.: Laos, Mt. Pu Bia, Chieng Khuang, leg. Kerr, 1932, No. 506; holotype in BM. — *Trachypodopsis angustiretis* Dix.: Sumatra, Mt. Goh Lemboeh, leg. van Steenis, 2-1937, No. 10212; holotype in BM. — *Trachypodopsis subulata* Chen, Szechwan, Hwayun-schan, leg. Chen, 11-7-1937, No. 634a; type not seen. — *Trachypodopsis crispatula* (Hook.) Fleisch. var. *longifolia* Nog. homonym illeg.: Formosa, Prov. of Tainan, Mt. Kodama, leg. Noguchi, 8-1932, No. 6803; holotype in HIRO (not seen).

Medium sized to fairly robust plants in mostly somewhat glossy, lax or more or less dense mats or hanging down. Secondary stems up to *25 cm* long, procumbent or hanging down, more or less irregularly pinnately branched, rarely rather densely pinnately branched, occasionally dichotomously branched. Leaves appressed to horizontally spreading when dry, up to *4 mm* long, mostly *strongly longitudinally plicate*, more or less crisped near apex, from an ovate or broadly ovate, *auriculate base long- to very long- and narrowly acuminate.* Auricles *medium sized* to *rather large*, often somewhat protruding, sometimes faintly shaped like a snail-shell. Leaf cells *2—8* times as long as wide, rarely up to *10* times as long as wide, border cells mostly *more or less differentiated.*

Sporophyte as in the diagnosis of the genus.

India: Simla: leg. Determes, 5-1897, c.fr. (L, No. 910.132—943 and No. 912.304—145); leg. Doulea, 19-11-1900, No. 3047 (PC, T. subcrispatula); leg. Doulea, 20-11-1900, No. 3047 (H, the same as the previous specimen ?). — Mussoorie: leg. Duthie, 2-1-1892, No. 635, c.fr. (H, T. subcrispatulus); Dhanoulti, leg. Bahadru, 10-12-1903, No. 5861 (H); Arnigadh, leg. Gollan, 15-12-1895, Levier No. 82 (K, T. subcrispatula). — Sikkim: Lachung, herb. Ind. Or. Hook. f. et Thoms. No. 853 (K); Jonglo, herb. Ind. Or. Hook. f. et Thoms. No. 875 (K); Silake, leg. Gammie, 1-1898, No. 11435 p.p. (H); Darjeeling, leg. Determes, 1896 (PC, T. himantophyllus, isolectotype). — Assam: Naga Hills, leg. Micholitz, 12-1910 (L). — Calcutta: leg. Griffith, No. 72 (PC). — Kumaon: Gori Valley, Parbhu, leg. Inayat, 12-8-1900 (H). — Madura: Palni Hills, leg. Foreau, 1953, No. 213 (GRO). — Himalaya without definite locality: leg. Determes (PC). — India without definite locality: herb. Ind. Or. Hook. f. et Thoms. No. 867, c.fr. (K); ibid. No. 849 (H, L), No. 850, c.fr. (L) and No. 858 (L); Bababoodaus, Kulhutty, leg. Meebotch, 10-1908 (H).

Nepal: leg. Buchanan (K, holotype); leg. Wallich, herb. Hookerianum, No. 2125, (K); leg. Gardner, herb. Hookerianum, No. 2124, c.fr. (K); leg. Wallich (L); leg ?, c.fr. (L, No. 910.132—935 and No. 910.132—940).

Ceylon: Horton Plaines, leg. Fleischer, 2-1898, No. 198 (L); between Horton Plaines and Pattipola, leg. Herzog, 2-1906, No. 300 (L).

Burma: Yuennan frontier, leg. Micholitz, 10-1911 (L); Tenasserim, Mt. Moolegit, leg. Fea, 3-1887 (PC, T. feae).

China: Yuennan, near Tengyueeh, leg. Rock, No. 2991, c.fr. (L).

Laos: Mt. Pu Bia, Chieng Khuang, leg. Kerr, 1932, No. 506 (BM, T. plicata, holotype).

Formosa: Prov. of Tainan, Mt. Kodama, leg. Noguchi, 18-8-1932, No. 6809 (herb. Noguchi, T. crispatula var. longifolia).

Philippine Islands: Luzon: Subprov. of Ifugao, Mt. Polis, leg. MacGregor, 2-1913, Bur. Sc. No. 19926 (L); Subprov. of Benguet, leg. Mearns, 5-1907, No. 3386 (GRO, L); Subprov. of Benguet, leg. Santos, 4-6-1918, No. 32055 (K); Prov. of Abra, Mt. Posuey, leg. Ramos, 2-1917, Bur. Sc. No. 27097 (L).

Indonesia: Java: Tjibeurum, leg. Fleischer, 9-1902 (FH, T. macrodon, lectoholotype); Djati-Kalangan, leg. Junghuhn, No. 875 (L); leg. Junghuhn (L, No. 910.132—941); leg. Junghuhn (FH, T. macrodontis); Limbangan, leg. Korthals (L); leg. Korthals (L, No. 910.132—1018); comm. van der Sande Lacoste (L); Mt. Patoeha, leg. Verdoorn, 7-1930, No. 60 (GRO, L, T. macrodon); ibid. No. 701 (GRO, T. macrodon); leg. de Vriese (L, No. 910.132—1015); leg. de Vriese, 1858/60 (L, No. 910.132—1013 and No. 910.132—939); Tjibeurum, leg. van der Wijk, 18-3-1952, no. 404 (GRO). — Sumatra: Mt. Singgalang, leg. Beccari, 7-1878 (L, T. sumatrana); Padang, leg. Beccari, 1878, No. 69 (K, T. sumatrana); Atjeh, Mt. Goh Lemboeh, leg. van Steenis, 2-1937, No. 10212 (BM, T. angustiretis, holotype). — Lombok: Kalimati near Sambalun, leg. Elbert, 19-5-1909, No. 1449 (L, No. 943.8—84 and No. 943.5—41). — Halmaheira: leg. de Vriese, 1858/60 (H, L, No. 910.132—936, 910.132—1014 and No. 940.118—8).

Mexico: State of Hidalgo, near Honey Station, leg. Pringle, 7-10-1909, No. 1565—7 (PC, T. otiophylla).

Distribution: *Asia:* Himalaya, Southern India, Assam, Calcutta, Burma (Chin Hills, Tenasserim, Kengtung State, Mang Loen State); Andaman Islands, Yuennan, Szechwan, Laos, Formosa, Philippine Islands, Java, Sumatra, Celebes, Lombok, Halmaheira. *Central America:* Mexico, Guatemala.

Perhaps also Hong Kong (*cf.* Dixon, l. c. 1933).

Very common in South-East Asia.

Ecology: On trees, calcareous rocks, sandstone etc. or growing terrestrial from low altitudes up to 3400 m.

According to Herzog, Geogr. Moose (1926)143, this variety is one of the most important mosses of the mass vegetation of the mountain forests of South-East Asia.

Notes. 1. The present variety is a very variable one. The characters which may vary are a) the mode of branching and the length of the stems and branches, b) the aspect of the stems and branches, c) the direction of the leaves, d) the shape of the leaves, e) the degree of toothing of the leaf margin, f) the distinctness of the leaf border, g) the shape of the leaf cells.

a) The secondary stems and branches are mostly rather long, irregularly pinnately branched, procumbent or hanging down, but occasionally there occur plants which are more compact and with short stems (only a few cm long) and therefore inclining somewhat towards var. *guilbertii* (P. Vard.) Zant.

b) The aspect of the stems and branches varies from complanately foliate to foliate all around stem. The leaves are mostly irregularly inserted, but there also occur plants which have their leaves partially inserted in distinct longitudinal rows (*e. g.* India, Bababoodaus, Kulhutty, leg. Meebotch, 10-1908 (H)).

c) The direction of the leaves varies from appressed to horizontally spreading when dry. The stem leaves are often somewhat more appressed than the branch leaves. There occasionally occur plants (among them the type specimen of *T. crispatula* (Hook.) Fleisch.) that have strongly falcate-second leaves on some stems or branches (these leaves then mostly asymmetrical), whereas the leaves on other stems or branches are not falcate-second.

d) The leaves are mostly rather long-acuminate, but there also occur plants that have very long- and narrowly acuminate leaves. These plants were described by Reimers as *T. crispatula* ssp. *longifolia* Reim. (l. c. 1931) and by Noguchi as *T. crispatula* var. *longifolia* Nog. homonym illeg. (l. c. 1939).

e) The degree of toothing varies from faintly to strongly serrate or toothed. Sometimes the teeth themselves are finely denticulate.

f) The distinctness of the leaf border may vary from wholly lacking to fairly distinct. This variability is sometimes found on the same plant.

g) The shape of the median leaf cells may vary from almost isodiametric to linear (1—10 times as long as wide). The cells towards the apex are mostly shorter (not always!) and those towards base mostly longer than the median leaf cells. On an average they are 3—8 times as long as wide.

Plants with short leaf cells (1—3 times as long as wide) are rather rare (*e. g.* the specimens identified as *T. subcrispaluta* (C. Muell.) Fleisch. nom. nud. and as *T. feae* (C. Muell.) Fleisch.) and incline towards var. *guilbertii* (P. Vard.) Zant.

The type specimen of *T. angustiretis* Dix. has linear leaf cells (about 10 times as long as wide).

2. In 1905 Renauld and Cardot say concerning the species *Trachypus himantophyllus* Ren. et Card. (l. c. 1905), they described before: "Il nous semble même maintenant impossible d'y voir autre chose qu'une simple forme verte et grêle du *Trachypus crispatulus*, à feuilles moins denses, non homotropes, non ou à peine crispée, à rameaux plumeux, à capsule plus petite et plus courte; de plus, les cellules basilaires sont généralement très poreuses, et les cellules supérieures sont plus courtes; mais tous ces caractères sont peu stables et on rencontre des échantillons qui restent indécis entre les deux formes."

Dixon says of this species (l. c. 1937): "It is quite a marked plant, but I doubt whether it is more than a variety of *T. crispatula.*"

From the above it follows that *T. himantophylla* must be very closely allied to var. *crispatula*, and comparing the type specimen of *T. himantophylla* with var. *crispatula* it turned out that *T. himantophylla* fell entirely within the limits of *T. serrulata* var. *crispatula.*

3. In 1908 Fleischer described a new species *Trachypodopsis macrodon* Fleisch. (l. c. 1908) saying: "Diese Art unterscheidet sich von *Trachypodopsis crispatula* (Mitt.) vom indischen Festland, der sie sehr ähnlich ist und mit der sie in Bryol jav. l. c. vermengt ist, durch etwas gedrungneren Habitus, regelmässiger gefiederte Stengel, deutlicher gescheitelte, herabgebogene und etwas dichter gestellte Blätter mit deutlicheren Saumzellen, kürzeren Blattzellen und grösser gezähntem Blattrand.

Alle mir bekannten Exemplare aus Java, auch die Originalexemplare (Junghuhn) aus Java, gehören nicht zu *T. crispatula,* welche auf Java nicht vorzukommen scheint, sondern zu dem oben beschriebenen *T. macrodon* n. sp."

All the differences mentioned by Fleischer are characters in which *T. serraluta* var. *crispatula* may vary and when I compared the type specimen of *T. macrodon* with var. *crispatula* it turned out that *T. macrodon* fell entirely within the limits of var. *crispatula.*

Froehlich too states that he cannot affirm the differences between *T. macrodon* Fleisch. and *T. crispatula* (Hook.) Fleisch. mentioned by Fleischer, where the former writes (l. c. 1953): "Nach Fleischer gehören die Exemplare aus Java zu seiner *Trachypodopsis macrodon* und sollen die Autoren der Br. jav. diese seine Art mit *T. crispatula* vermengt haben. Möglicherweise gehört unsere Pflanze zur Fleischerschen Art, von der ich keinen Beleg habe, doch kann ich die von Fleischer angegebenen Unterschiede — abgesehen von der um eine Nuance etwas stärkeren Zähnung des Blattrandes — nicht herausfinden, insbesondere stimmen nicht die kürzeren Blattzellen, die ich übrigens auch bei *T. crispatula* ab und zu getroffen habe (Baumgartner)."

4. I have not seen the type specimen of *Trachypodopsis otiophylla* (Card.) Card., but I did see another specimen of herb. Cardot from Mexico. All the characters of this specimen fall entirely within the limits of *T. serrulata* var. *crispatula.*

Of this species Cardot (l. c. 1911) says: "C'est une *Trachypodopsis,* très voisin du *T. crispatula* (Hook.) Fl. de l'Inde s'en distinguant toutefois par sa teinte plus verte, ses rameaux comprimes, ses feuilles pourvues d'orcillettes plus grandes et plus accusées, et son tissu plus chlorophylleux, formé de cellules plus courtes, à parois beaucoup moins épassies."

According to Bartram too this species hardly differs from *T. crispatula* (Hook.) Fleisch., where he writes (l. c. 1949): "In vegetative features these plants differ little if any from the widespread *T. crispatula* (Hook.) Fleisch. of southeastern Asia and Malaysia. Unless there is some distinction in the sporophyte I doubt if they can be separated."

5. The type specimen of *Trachypodopsis densifolia* Broth. has probably been lost (the capsule is present in H, but without moss), but judging from the diagnosis and the figure given by Brotherus (l. c. 1929) it is almost certain that this species belongs to *T. serrulata* var. *crispatula.*

6. In his original description of *Trachypodopsis plicata* Dix. (l. c. 1936) Dixon writes: "Intermediate between *T. auriculata* and *T. crispatula*; it has the robust habit and plicate leaves of the former, and the leaves usually but little crisped, while the auricles are much smaller and often only slightly developed; the marginal toothing is very coarse, the teeth irregular in size and direction, often almost ciliate, and frequently themselves shortly denticulate."

The leaves of *T. serrulata* var. *crispatula* however are mostly also strongly plicate and the habit may be fairly robust. In fact the type specimen of *T. plicata* Dix. is hardly to be distinguished from most plants belonging to *T. serrulata* var. *crispatula.*

7. Chen described a new species *Trachypodopsis subulata* Chen (l. c. 1955), which I have not seen, but which species was said to be distinguished from the other *Trachypodopsis* species mainly by its arborescent branching. This mode of branching however also occurs in plants belonging to *T. serrulata* var. *crispatula,* although in a less extreme manner. The further differences (according to the description by Chen) were said to be the very long-acuminate leaves and the larger auricles. These characters however also fall entirely within the limits of var. *crispatula.* In fact, in my opinion *T. subulata* is only an extreme case of var. *crispatula* with an arborescent branching and very long-acuminate leaves. The auricles are not larger than in most plants belonging to var. *crispatula* (according to the figure given by Chen).

8. The robust specimens with long-acuminate, strongly longitudinally plicate leaves of *T. serrulata* var. *crispatula,* in habit much resemble *T. auriculata,* but are always recognizable in having smaller, not or faintly snail-shell-shaped auricles and papillose leaf cells.

1c. Trachypodopsis serrulata (P. Beauv.) Fleisch. var. **guilbertii** (Thér. et P. Vard.) Zant. comb. nov. — Plate IV, Fig. 1e and 1f. Plate V, Map 1.

Duthiella guilbertii Thér. et P. Vard.: Potier de la Varde, Rev. Bryol. Lich. 15(1946)146.

Type specimen: *Duthiella guilbertii* Thér. et P. Vard.: Cambodia, near Saigon, leg. Guilbert, 5-1935, herb. Potier de la Varde, No. 6366; holotype in PC.

Moderately slender to medium sized plants in dull mats. Secondary stems *short,* only a few cm long, procumbent, remotely, irregularly branched. Leaves spreading to horizontally spreading when dry, up to *2.5 mm* long, *crisped when dry, not or faintly longitudinally plicate,* from an ovate, *faintly auriculate* base rather long- and narrowly acuminate. Auricles small, slightly protuding. Median leaf cells *1—3* times as long as wide, border cells more elongate, forming a *distinct border,* cells in the lower part of the leaf more elongate, up to 6 times as long as wide; alar cells few, but distinct.

Sporophyte not known.

CAMBODIA: near Saigon, leg. Guilbert, 5-1935, herb. Potier de la Varde, No. 6366 (PC, Duthiella guilbertii, holotype).

Distribution: Cambodia only.

Ecology: No data extant.

Notes. 1. This variety is in general clearly distinguished from the other varieties, there occur however some intermediate forms with var. *crispatula* (see there, note 1a and 1g).

The main differences with var. *crispatula* are the following:

a. less robust, with shorter stems and smaller leaves,
b. leaves not or faintly longitudinally plicate,
c. leaf border more distinct,
d. leaf cells shorter,
e. auricles smaller,

and those with var. *serrulata:*

a. less robust, with shorter stems and smaller leaves,
b. leaf border distinct,
c. leaf cells shorter,
d. auricles slightly protruding.

2. When Potier de la Varde and Thériot described this new species (l. c. 1946) they incorporated it within the genus *Duthiella*, but although the sporophyte is not known, it is more likely that this plant should belong to the genus *Trachypodopsis* for the following reasons:

a. The species belonging to the genus *Duthiella* are in general not auriculate, but if auricles do occur (*D. speciosissima* Card.) they are not protruding and the leaf margin passes gradually into the leaf base; the auricles of *D. guilbertii* are somewhat protruding and the leaf margin passes more or less abruptly into the leaf base, exactly as is the case in all *Trachypodopsis* species (with the only exception of *T. serrulata* var. *serrulata*).

b. The occurence of intermediate forms between *D. guilbertii* and *T. serrulata* var. *crispatula*.

3. This variety also bears a slight resemblance to *Duthiella declinata* (Mitt.) Zant. (this species hitherto used to belong to the genus *Trachypodopsis*!), but is *i. a.* clearly distinguishable by the presence of leaf auricles.

2. **Trachypodopsis formosana** Nog. — Plate IV, Fig. 2. Plate V, Map 3. Noguchi, J. Hattori Bot. Lab. (= J. Hattori Shokub. Kenk.) 2(1947)59.

Type specimen: Formosa, Prov. of Taichu, Mt. Noko, leg. Suzuki, 8-1929, No. 575.

Fairly robust plants in rather dense, yellowish-green or brownish, dull-glossy mats. Secondary stems up to about *15 cm* long, irregularly pinnately branched, rigid, densely foliate. Leaves erect spreading to horizontally spreading when dry, spreading to horizontally spreading when moist, up to *7 mm* long, from an ovate, auriculate base more or less gradually *long- to very long-acuminate, strongly longitudinally plicate,* crisped near apex when dry; leaf margin rather faintly serrate. *Auricles large,* often somewhat protruding, more or less shaped like a *snail-shell, breaking off easily.* Leaves of the lower parts of the secondary stems shorter acuminate and more or less deltoid. Leaf rib single, ending below apex. Leaf cells elongate to sublinear (3—8 times as long as wide), *part of them unipapillate* over lumen (rarely with 2 papillae), *the others smooth,* border cells not differentiated, cells towards base more elongate, smooth; alar cells present, *rather large,* filling the greater part of the auricles, quadrate to rectangular, smooth; cell walls mostly moderately incrassate, pitted.

Sporophyte as in the diagnosis of the genus (capsule not known).

FORMOSA: Prov. of Taichu, Mt. Noko, leg. Suzuki, 8-1929, No. 575 (herb. Noguchi, holotype).

Distribution: Formosa only.

Ecology: No data.

Note. The present species is somewhat intermediate between *T. serrulata* (P. Beauv.) Fleisch. and *T. auriculata* (Mitt.) Fleisch.

From the latter it is mainly distinguished by the following characters:

a. leaves longer acuminate,
b. auricles somewhat smaller,
c. alar cells more distinct, filling the greater part of the auricles,
d. part of the leaf cells unipapillate over lumen (rarely with 2 papillae),

and from the former by:

a. leaves longer acuminate,
b. auricles larger, always more or less shaped like a snail-shell,
c. alar cells more distinct, filling the greater part of the auricles,
d. only part of the leaf cells unipapillate over lumen (rarely with 2 papillae), the others smooth.

3. **Trachypodopsis auriculata** (Mitt.) Fleisch. — Plate IV, Fig. 3. Plate V, Map 2.

Trachypodopsis auriculata (Mitt.) Fleisch., Hedwigia 45(1906)67; Brotherus, Nat. Pfl. 1, 3(1906)832; Herzog, Hedwigia 50(1910)136; Dixon, J. of Bot. 50(1912)151; Fleischer, Hedwigia 61(1920)404; Brotherus, Nat. Pfl. ed. 2, 11(1925)122; Sasaoka, Trans. Nat. Hist. Soc. Formosa 18(1928) n. 97 (not seen); Brotherus, Symb. Sin. 4(1929)77; Bruehl, Rec. Bot. Surv. India 13, 1(1931)68; Dixon, J. Bombay Nat. Hist. Soc. 39(1937)781; Herzog, Ann. Bryol. 12(1939)91; Horikawa in Asahina, Nippon Inkwasyokubutu Dukan (1939)937 (not seen); Noguchi, J. Hattori Bot. Lab. 5(1951)23.

Trachypus auriculatus Mitt., J. Linn. Soc. Bot. Suppl. 1(1859)129; Paris, Ind. Bryol. (1898)1303; ibid. ed. 2, 5(1906)63; Fleischer, Hedwigia 61(1920)404.

Papillaria auriculata (Mitt.) Jaeg., Ber. S. Gall. Naturw. Ges. 1875/76 (1877)274 = Ad. 2(1877)178.

Pilotrichum auriculatum Wils. nom. nud.: Mitten, J. Linn. Soc. Suppl. 1(1859)129; Jaeger, Ber. S. Gall. Naturw. Ges. 1875/76(1877)274 = Ad. 2(1877)178.

Hemiragis ornans Reich, Beitr. (?)577 (not seen).

Hookera ornans (Reich.) Par., Ind. Bryol. (1896)581.

Trachypus ornans (Reich.) C. Muell., Fl. 82(1896)465; Paris, Ind. Bryol. (1898)1303; Brotherus, Bull. Soc. Bot. Ital. 1904(1904)24; Paris, Ind. Bryol. ed. 2, 5(1906)64; Fleischer, Hedwigia 61(1920)404.

Trachypodopsis ornans (Reich.) Fleisch. syn. nov.: Fleischer, Hedwigia 45(1906)68; Brotherus, Nat. Pfl. 1, 3(1906)832; Fleischer, Hedwigia 61 (1920)404; Brotherus, Nat. Pfl. ed. 2, 11(1925)122; Brotherus, Bish. Mus. Bull. 40(1927)20.

Trachypus ornans (Reich.) C. Muell. f. *simplex* Broth. syn. nov.: Brotherus, Bull. Soc. Bot. Ital. 1904(1904)24.

Trachypodopsis auriculata (Mitt.) Fleisch. f. *pendula* Herz. syn. nov.: Herzog, Ann. Bryol. 12(1939)91.

Trachypus craspedophyllus C. Muell. nom. nud.: Fleischer, Hedwigia 45 (1906)68; ibid. 61(1920)404.

Trachypodopsis craspedophylla (C. Muell.) Fleisch. nom. nud.: Fleischer, Hedwigia 45(1906)68; ibid. 61(1920)404.

Type specimens: *Trachypodopsis auriculata* (Mitt.) Fleisch.: India, Sikkim, leg. Hooker, No. 863; lectoholotype in K. — *Trachypodopsis ornans* (Reich.) Fleisch.: Hawaiian Islands, Maui, leg. Wawra, No. 2147; lectoholotype in W (under the name of Hemiragis ornans). — *Trachypus ornans* (Reich.) C. Muell. f. *simplex* Broth.: Hawaiian Islands, Maui, leg. Baldwin, 1875; type probably lost. — *Trachypodopsis auriculata* (Mitt.) Fleisch. f. *pendula* Herz.: India, Sikkim, Darjeeling, Tsomgo Lake, leg. Troll; type not seen.

Dioicous; fairly robust, greenish (in herb. mostly brownish), never blackish plants in dull-glossy or somewhat glossy, lax mats or hanging down. Secondary stems up to *30 cm* long, procumbent or hanging down, rather remotely, irregularly pinnately, occasionally dichotomously branched. Secondary stems and branches fairly densely, mostly somewhat complanately foliate. Leaves mostly spreading (stem leaves occasionally appressed) when dry, spreading to horizontally spreading when moist, up to *5 mm* long, from a broadly ovate, strongly auriculate base, mostly gradually, *long-acuminate, strongly longitudinally plicate,* often crisped near apex; leaf margin faintly to strongly toothed or serrate, teeth themselves sometimes finely denticulate. *Auricles very large,* shaped like a *snail-shell.* Leaf rib single, ending below apex. Leaf cells elongate to linear (4—10 times as long as wide), *smooth,* border cells not differentiated; cells in the auricles shorter and irregular in shape; alar cells *hardly developed;* cell walls rather thin to incrassate and pitted.

Sporophyte as in the diagnosis of the genus. Seta up to *18 mm* long and capsule up to *3 mm.*

INDIA: Sikkim: Phaluth, leg. Kurz, No. 2410, c.fr. (L); Kurseong, leg. Decoly, 22-9-1898, No. 449, c.fr. (H); Darjeeling, leg. Wichura, 16-4-1862, No. 2892b (H); Jonglo, herb. Ind. Or. Hook. f. et Thoms. No. 864 (K); Mainamcha, herb. Ind. Or. Hook. f. et Thoms. No. 863, c.fr. (K, lectoholotype); leg. Kurz, No. 2078 (H, Trachypus craspedophyllus). — Bhutan: leg. Griffith (PC). — Himalaya without definite locality: herb. Ind. Or. Hook. f. et Thoms. No. 952 (L); Cusriang, leg. Wichura, 7-4-1862, No. 2892d, c.fr. (H).

HAWAIIAN ISLANDS: Maui: leg. Wawra, No. 2147 (W, Hemiragis ornans, lectoholotype); Haleakala, Kula pipe line, leg. Skottsberg, 18-10-1922, No. 1176 (H, T. ornans). — Oahu: leg. Wawra (W, Hemiragis ornans).

Distribution: India: (Sikkim, Bhutan, Assam); Yuennan (fid. Brotherus, l. c. 1929); Ceylon (fid. Herzog, l. c. 1910); Formosa (fid. Noguchi, l. c. 1947); Hawaiian Islands.

Ecology: On trees. Alt.: Hawaiian Islands 700—1600 m; Himalaya 2000—3500 m; Ceylon 1700 m.

Notes. 1. This species, which is very easily recognizable in having smooth leaf cells and very large, snail-shell-shaped auricles, may vary somewhat in the length of the leaf cells.

All the plants I saw from the Hawaiian Islands have got rather long leaf cells (up to 10 times as long as wide), whereas on the continent there also occur plants with shorter leaf cells, besides those with leaf cells up to 10 times as long as wide. Sometimes more elongate leaf cells are concomitant with more incrassate cell walls.

2. Herzog mentions a forma *pendula* Herz. (l. c. 1939) saying: "Sie wächst in ca. 30 cm langen Bärten von rötlicher Färbung offenbar an Baumästen der Waldgrenze, während die Normalform in tieferen Berglagen beheimatet sein dürfte." Although I have not seen the type specimen it is in my opinion not practical to name those forms.

3. According to Herzog, Geogr. Moose (1926)143, the natives of the Hawaiian Islands use this species as ornaments in their dance-crowns.

4. **Trachypodopsis laxoalaris** Broth. in Mildbr. — Plate XI, Fig. 1, Plate V, Map 3.

Brotherus, Wiss. Erg. Deut. Zentr. Afr. Exp. 2, 1(1910)160; Brotherus, Nat. Pfl. ed. 2, 11(1925)122; Demaret, Bull. Jard. Bot. Et. Bruxelles 16, 1(1940)75; Potier de la Varde, Ark. Bot. 2, 3, 8(1955)178.

Type specimen: Ruwenzori, Butagu Valley, leg. Mildbraed, 2-1908, No. 2660; holotype in H.

Fairly robust, yellowish-green plants in dull-glossy mats. Secondary stems up to *20 cm* long, procumbent or hanging down, remotely, irregularly pinnately branched. Secondary stems and branches densely, somewhat complanately foliate. Leaves spreading to horizontally spreading when dry, up to *3.5 mm* long, *not or rather faintly longitudinally plicate,* crisped near apex, from a broadly ovate, auriculate base more or less gradually, rather long-acuminate; leaf margin moderately toothed, teeth irregular in size and direction. Leaves of the lower parts of the secondary stems shorter acuminate. *Auricles moderately developed,* not or faintly protruding. Leaf rib single, ending below apex. Leaf cells elongate to linear (5—10 times as long as wide), on both sides *unipapillate* over lumen, border cells not differentiated, mostly smooth, cells towards base more elongate (basal cells however rather short and wider), smooth; *alar cells numerous, large,* more or less *gradually* passing into the lamina cells, quadrate to rectangular, smooth; cell walls somewhat incrassate, pitted.

Sporophyte not known.

RUWENZORI: Butagu Valley, leg. Mildbraed, 2-1908, No. 2660 (H, holotype).

Distribution: Ruwenzori only.

Ecology: On dry precipice at 2700 m altitude.

Note. The present species is closely allied to *Trachypodopsis serrulata* (P. Beauv.) Fleisch. var. *serrulata,* but is clearly distinguished in having numerous, large alar cells, which fill almost the whole auricles. Hitherto no intermediate forms have been found.

5. **Trachypodopsis normandi** (Broth. et Par.) Fleisch. — Plate VI, Fig. 3 Plate V, Map 3.

Trachypodopsis normandi (Broth. et Par.) Fleisch., Hedwigia 45

(1906)68; Brotherus, Nat. Pfl. 1, 3(1906)831; ibid. ed. 2, 11(1925)121; Taylor and Potier de la Varde, Kew Bull. 4(1954)510.

Trachypus normandi Broth. et Par., Rev. Bryol. 29(1902)68; Paris, Bull. Soc. Bot. France 8, 4, 14(1908)35.

Type specimen: French Guinea, Fouta Jalon, leg. Normand, 5-4-1901; lectoholotype in H.

Dioicous ?; *moderately slender to medium sized,* green or yellowish-green plants in dull or dull-glossy mats. Stems irregularly pinnately, to fairly regularly pinnately branched, branches up to *1,5 cm* long. Leaves spreading, recurved near apex when dry, erect spreading when moist, up to *1.5 mm* long, *more or less longitudinally plicate,* undulate near apex, from an ovate, somewhat auriculate base gradually acuminate; leaf margin partially recurved, faintly to moderately serrate. Leaves of the lower parts of the secondary stems shorter acuminate. *Auricles rather small,* the leaf margin mostly somewhat abruptly passing into the leaf base. Leaf rib single, ending below apex. Leaf cells elongate to sublinear (2—8 times as long as wide) on both sides unipapillate over lumen, border cells more elongate, forming *a more or less distinct border,* mostly smooth, cells towards base more elongate, smooth; *alar cells well developed,* consisting of about 5—10 large, rectangular to quadrate cells, *abruptly* passing into smaller, more or less quadrate leaf cells which gradually pass into the elongate lamina cells; cell walls rather thin to moderately incrassate.

Male gametioecia as in the diagnosis of the genus.

Sporophyte not known.

French Guinea: Fouta Jalon, leg. Normand, 5-4-1901 (H, lectoholotype).

Distribution: French Guinea and Sierra Leone.

Ecology: On trees, rocks, or terrestrial. Alt. 800—1800 m.

Note. *T. normandi* (Broth. et Par.) Fleisch. is the smallest species of the genus and always easily recognizable by its aberrant alar cells.

3. **Diaphanodon** Ren. et Card.

Renauld and Cardot, Rev. Bryol. 22(1895)33; ibid. Bull. Soc. Roy. Bot. Belg. 34, 2(1896)67; ibid. 38, 1(1900)23; Brotherus, Nat. Pfl. 1, 3(1906)828; Fleischer, Musci Fl. Buitenzorg 3(1908)746; Brotherus, Nat. Pfl. ed. 2, 11(1925)117.

Dioicous; *slender to medium sized,* green or brownish-green plants in more or less dense, dull mats, older parts often blackish. Primary stems

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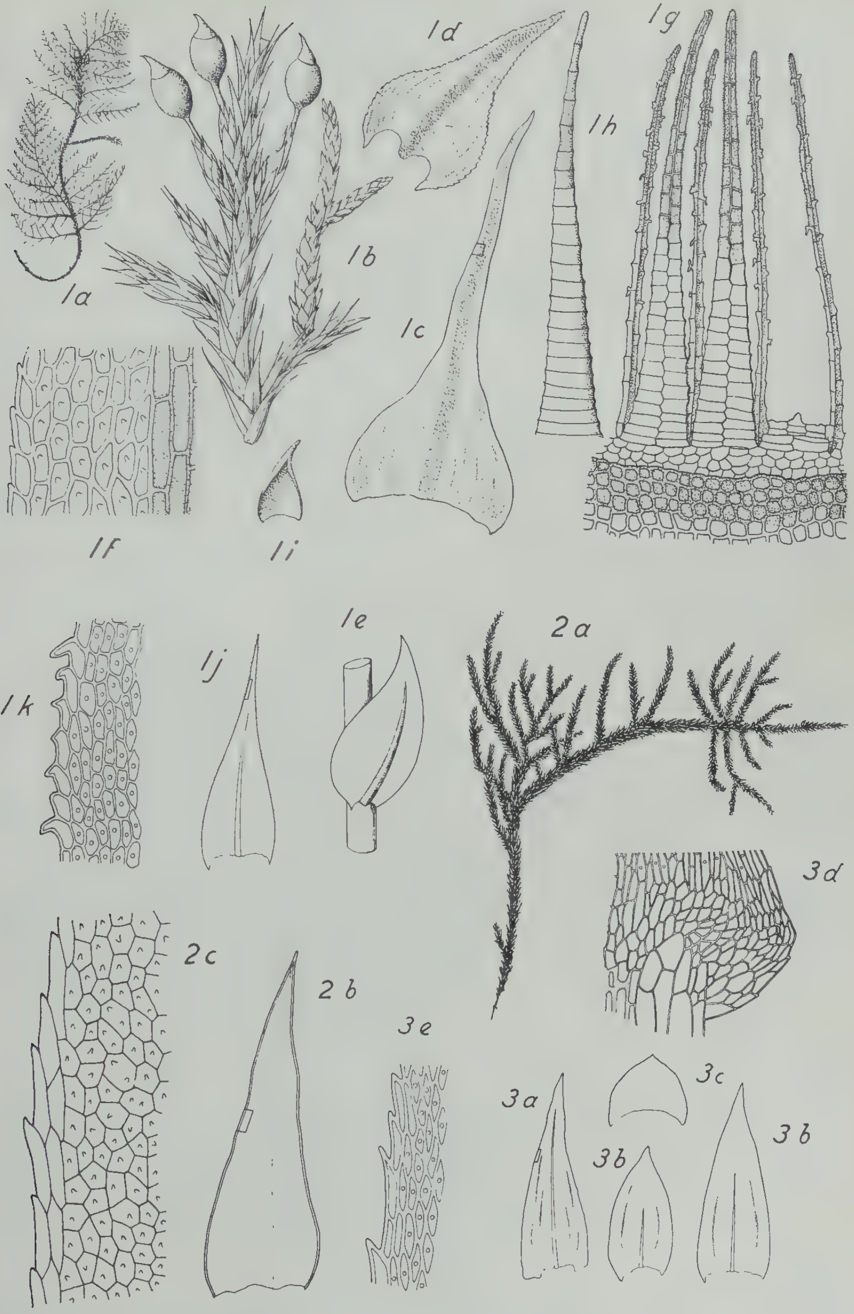
Plate VI. — Fig. 1a–i: *Diaphanodon blandus* (Harv.) Ren. et Card. var. *blandus,* 1a habit (1/1), 1b part of stem with capsules (8/1), 1c stem leaf (40/1), 1d branch leaf (80/1), 1e hollow branch leaf (100/1), 1f leaf cells (275/1), 1g peristome (150/1), 1h exostome tooth, inner face (150/1), 1i calyptra (8/1); Fig. 1j, k: var. *recurvedentatus* Zant., 1j branch leaf (80/1), 1k leaf cells (200/1); Fig. 2: *Diaphanodon procumbens* (C. Muell.) Ren. et Card., 2a habit (2/1), 2b leaf (25/1), 2c leaf cells (275/1); Fig. 3: *Trachypodopsis normandi* (Broth. et Par.) Fleisch., 3a stem or branch leaf (20/1), 3b stem leaves (20/1), 3c leaf of primary stem (20/1), 3d auricle and alar cells (150/1), 3e leaf cells (150/1). (Fig. 1a–d and f–i after Brotherus, Nat. Pfl. ed. 2, 11(1925)118, Fig. 1e, 1j, 1k and Fig. 2 and 3 original).


1a
1b
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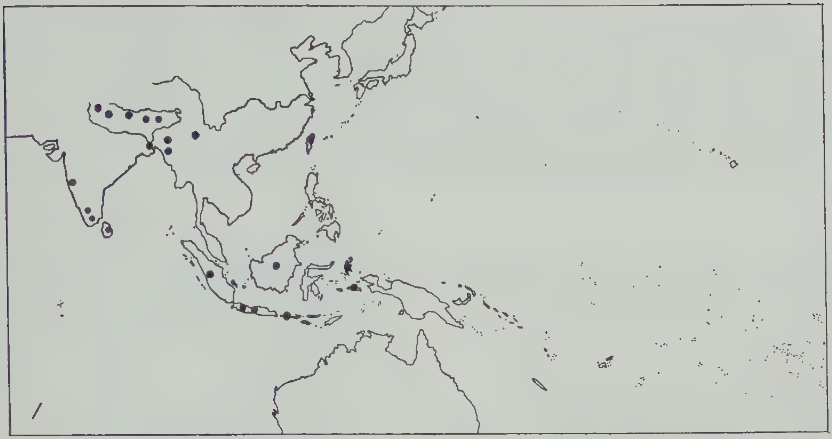
3b

creeping, with tufts of blackish rhizoids and more or less scale-like lower leaves. Secondary stems rather short or up to 15 cm long, mostly procumbent, *densely bipinnately* or pinnately branched or rather remotely more or less pinnately, occasionally slightly paniculately branched, often with innovations. Plants occasionally with flagelliform, rather laxly foliate stems. Central strand mostly wanting, never well developed. *Paraphyllia absent.* Stems and branches mostly densely foliate, branches sometimes hamate or filiform at tips. Leaves either dimorphous or not, up to 1.5 mm long, appressed to erect spreading when dry, erect spreading to horizontally spreading when moist, from an ovate or broadly ovate, *not auriculate,* somewhat decurrent base gradually or somewhat abruptly acuminate, plane or more or less concave; leaf margin almost entire to strongly toothed or serrate, often partly recurved. If dimorphous the branch leaves smaller, shorter and more gradually acuminate than the stem leaves. Leaf rib single, ending below apex or passing into the border cells. Leaf cells *isodiametric to elongate* (up to 6 times as long as wide), on both sides *unipapillate* over lumen (rarely with two papillae); border cells either more elongate and forming a distinct border or not, mostly smooth; cells towards base more elongate, smooth; alar cells present, but sometimes few and inconspicuous, quadrate to rectangular, smooth; cell walls rather thin to incrassate.

Sporophyte lateral on the secondary stems or branches. Female gametoecia numerous, lateral on the secondary stems or branches, bud-shaped, with a number of archegonia, without paraphyses. Perigamial leaves from an ovate base long-acuminate, often tortuous at tips, the outer leaves small and very short-acuminate; leaf margin almost entire; rib present, but often indistinct; leaf cells elongate (3—10 times as long as wide), more or less incrassate, mostly unipapillate over lumen. Archegonia bottle-shaped, long-necked, brownish-red. Male gametoecia not known. Seta about *2 mm* long, *mamillose,* especially in the upper part, reddish, not contorted when dry. Vaginula short-cylindrical, smooth, with a number of archegonia, without paraphyses. Perichaetial leaves like the perigamial leaves, but longer and narrower acuminate, enveloping the greater part of the seta, papillae on the leaf cells less distinct. Capsule *subglobose to ovoid, erect,* about 1.5—2 mm long, without neck, somewhat contracted below the mouth when dry, reddish, with stomata; exothecium cells quadrate or rectangular to hexagonal, in longitudinal rows, towards the mouth smaller, slightly incrassate. Lid conical, somewhat obliquely rostrate. Peristome double. Exostome teeth 16, on a low basal membrane, lanceolate-subulate, with a zigzag median line, trabeculate, especially in the upper part, smooth, in the upper part papillose, yellowish. Endostome disappearing with the spore-sac. Endostome teeth 16, on a rather well developed, papillose basal membrane, narrowly lanceolate, towards the ends more or less filiform, somewhat shorter than the exostome teeth, carinate, papillose. *Cilia absent.* Calyptra small, *cucullate,* naked. Spores large, 30—45 μ in diameter, globular, faintly papillose, yellowish.

Plate VII. — Map 1: Area of *Diaphanodon blandus* (Harv.) Ren. et Card. var. *blandus*; Map 2: Area of *Diaphanodon blandus* (Harv.) Ren. et Card. var. *recurvedentatus* Zant. (×), var. *ceylonensis* Zant. (■) and of *Diaphanodon procumbens* (C. Muell.) Ren. et Card. (●); Map 3: Area of *Pseudospiridentopsis horrida* (Card.) Fleisch.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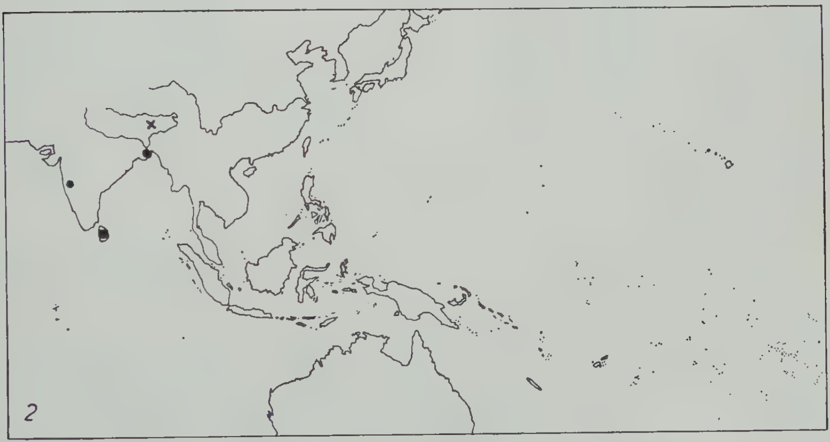
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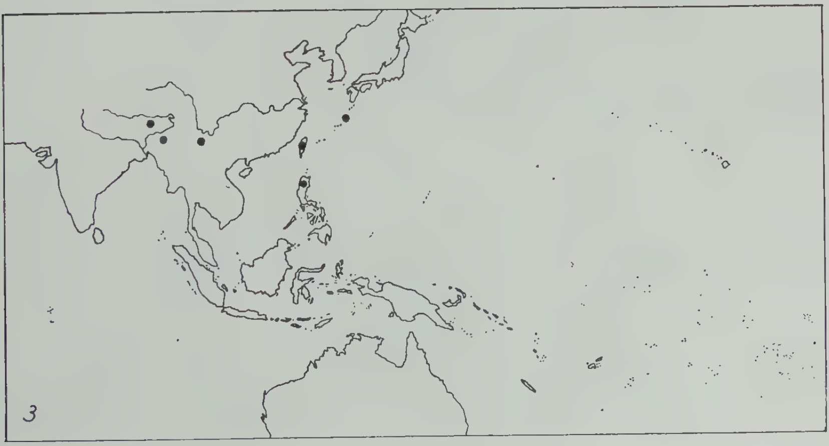
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History of the genus up to the present paper.

The genus *Diaphanodon* was described for the first time by Renauld and Cardot, Rev. Bryol. 22(1895)33, without indication within which family.

Type species was *D. thuidioides* Ren. et Card., but now becomes *D. blandus* (Harv.) Ren. et Card. as discussed below (*D. blandus,* note 7).

The following species and forms have successively been added to the genus:

D. procumbens (C. Muell.) Ren. et Card.	Bull. Soc. Roy. Bot. Belg. 38, 1(1900)24.
D. blandus (Harv.) Ren. et Card.	Bull. Soc. Roy. Bot. Belg. 38, 1(1900)23.
D. brotheri Ren. et Card.	Bull. Soc. Roy. Bot. Belg. 38, 1(1900)24.
D. javanicus Ren. et Card.	Rev. Bryol. 28(1901)117.
D. javanicus Ren. et Card. f. *gracilior* Ren. et Card. nom. illeg.	Rev. Bryol. 28(1901)117.
D. javanicus Ren. et Card. f. *robustior* Ren. et Card. ex Fleisch.	Musci Fl. Buitenzorg 3(1908)749.
D. ? gracillimus Card. et Thér.	Bull. Ac. Int. Géogr. Bot. 18, 219 (1908)II.

Fleischer incorporated the genus within the new family of the *Trachypodaceae* Fleisch., Hedwigia 45(1905)64.

Relationships.

Fleischer, Musci Fl. Buitenzorg 3(1908)728; ibid. 4(1923)1497; Reimers, Hedwigia 76(1937)210, 212.

Besides being related to the other genera of the family the genus *Diaphanodon* is, according to Fleischer (l. c. 1923), related to *Hylocomiopsis* and through this genus to *Tetrastichium, Helodium* and *Actinothuidium.* He writes: "Die polymorphe *Trachypodaceen*gattung *Diaphanodon* giebt uns den Schlüssel zur Entzifferung der phyletischen Herkunft der prächtigen Gattung *Actinothuidium* des Himalayagebietes und der stattlichen *Helodium* Arten. Unter den Arten von *Diaphanodon* ist besonders *D. thuidioides,* welches an die Gattung *Hylocomiopsis (Lescuraea) ovicarpa* anschliesst. Letztere Art ist auch mit der japanischen Gattung *Tetrastichium (Thuidium) Molkenboeri* (Lac.) und *Helodium paludosum* nahe verwandt."

Whether these relationships are of phylogenetical value is in my opinion doubtful.

According to Reimers (l. c. 1937, p. 212) the group of *Claopodium assurgens* (Sull. et Lesqu.) Card. closely resembles the genus *Diaphanodon* on account of the shape of the leaves and of the presence of papillae. The sporophytes are however quite different.

The genus *Diaphanodon* is in general easily distinguishable from the other genera. The gametophyte of *D. blandus* bears however close resemblance to some *Thuidiaceae* on account of the mode of branching, but it is mostly easily recognizable by the absence of paraphyllia. The sporophytes are quite different.

Relationships within the genus.

Although the sporophytes of the 2 species, *D. procumbens* (C. Muell.) Ren. et Card. and *D. blandus* (Harv.) Ren. et Card., which constitute the genus are wholly identical, the gametophytes are quite different.

D. procumbens is a stable species as contrasted with *D. blandus*, which species is a highly variable one and can be divided into a number of varieties, which are closely allied and connected by intermediate forms.

Excluded species.

Diaphanodon ? gracillimus Card. et Thér., Bull. Ac. Int. Géogr. Bot. 18, 219(1908)II; Brotherus, Nat. Pfl. 1, 3(1909)1227; ibid. ed. 2, 11(1925)118.

This species belongs probably to the family of the *Thuidiaceae* on account of the presence of numerous paraphyllia.

Geographical distribution.

Herzog, Geogr. Moose (1926)143, 340, 342, 351.

The distribution of the genus is restricted to South-East Asia: Himalaya, Southern India, Bombay, Calcutta, Ceylon, Indonesia and Formosa.

Diaphanodon blandus is found in all the above mentioned regions (except of Bombay and Calcutta) and belongs to the South-East Asian mountain forest flora.

Diaphanodon procumbens is only found in the surrounding of Bombay and Calcutta.

Ecology.

Mostly on trees, sometimes on rocks or growing terrestrial, from low up to high altitudes.

Note.

I have not seen any material of *Diaphanodon pfleideri* Broth. in Reim. nom. nud., mentioned by Reimers, Hedwigia 76(1937)217.

Key to the species

1. Stem and branch leaves not or faintly dimorphous; leaf border cells clearly differentiated; plants medium sized, mostly rather densely pinnately to somewhat bipinnately branched . . . . . **1. D. procumbens** (C. Muell.) Ren. et Card.
1. Stem and branch leaves clearly dimorphous; leaf border cells not or faintly differentiated; plants slender to fairly slender, mostly densely bipinnately branched (rarely stems long and rather remotely pinnately branched) **2. D. blandus** (Harv.) Ren. et Card.

1. Diaphanodon procumbens (C. Muell.) Ren. et Card. — Plate VI, Fig. 2. Plate VII, Map 2.

Diaphanodon procumbens (C. Muell.) Ren. et Card., Bull. Soc. Roy. Bot. Belg. 38, 1(1900)24; Paris, Ind. Bryol. ed. 2, 2(1904)2; Brotherus, Nat. Pfl. 1, 3(1906)829; Paris, Ind. Bryol. ed. 2, 5(1906)150; Dixon, J. of Bot. 50(1912)151; Bruehl, Rec. Bot. Surv. India 13, 1(1931) 67.

Neckera (sect. *Leptohymenium*) *procumbens* C. Muell., Syn. 2(1851)80.

Trachypus procumbens (C. Muell.) Mitt., J. Linn. Soc. Bot. Suppl. 1 (1859)127.

Leptodon procumbens (C. Muell.) Jaeg., Ber. S. Gall. Naturw. Ges.

1875/76(1877)203 = Ad. 2(1877)107; Paris, Ind. Bryol. (1897)729; ibid. ed. 2, 3(1905)146; Fleischer, Hedwigia 59(1917)212.

Dixon, J. of Bot. 47(1909)164 (under the name of Trachypodiopsis blanda (Mitt.) Fleisch., fid. Dixon, l. c. 1912).

Type specimen: India, Bombay, ex horto Dom. van Houtte, leg. Kegel; type in L (No. 910.95—106).

Dioicous; *medium sized*, green or brownish-green plants in fairly dense, dull mats. Secondary stems up to *4 cm* long, more or less regularly *pinnately to somewhat bipinnately* or slightly *paniculately* branched, densely foliate, *without innovations*. Stem and branch leaves *not or faintly dimorphous*. Leaves appressed to spreading when dry, spreading to horizontally spreading when moist, sometimes slightly falcate-second, from an ovate, not auriculate base more or less gradually, rather long-acuminate, *plane*. Leaf margin almost entire at base, moderately serrate towards apex, often recurved. Leaf rib single, near apex passing into the border cells. Leaf cells mostly hexagonal, *subisodiametric*, on both sides unipapillate over lumen (sometimes with two papillae); border cells more elongate, *forming a distinct border*, smooth; cells towards base quadrate to rectangular, smooth; alar cells inconspicuous, quadrate, smooth; cell walls rather thin, those of the basal cells somewhat more incrassate.

Sporophyte lateral on the secondary stems, further as in the diagnosis of the genus.

INDIA: Bombay: leg. Kegel, c.fr. (L, No. 910.95—105); herb. Kegel, No. 10027, c.fr. (L, No. 910.95—106, type); leg. ? (L, No. 910.95—104); Elphingstone, misit Levier, 1897, c.fr. (FH); Elphingstone, ex herb. Kegel-Schliephacke, c.fr. (FH); Irimbakeshwar, leg. Sedgwick, 9-1908, ex herb. Dixon (FH, Trachypodopsis blanda); leg. ? c.fr. (FH). — Calcutta: com. Cardot, c.fr. (FH).

Distribution: India (Bombay, Western Ghats and Calcutta).

Ecology: On stones and on trees at low altitudes.

2. **Diaphanodon blandus** (Harv.) Ren. et Card.

Diaphanodon blandus (Harv.) Ren. et Card., Bull. Soc. Roy. Bot. Belg. 38, 1(1900)23; Paris, Ind. Bryol. ed. 2, 2(1904)2; Brotherus, Nat. Pfl. 1, 3(1906)829; Herzog, Hedwigia 50(1910)135; Dixon, J. of Bot. 50(1912)151; Dixon, J. of Bot. 53(1915)290; Fleischer, Hedwigia 61(1920)404; Brotherus, Nat. Pfl. ed. 2, 11(1925)118; Bruehl, Rec. Bot. Surv. India 13, 1(1931)67; Dixon, J. Bombay Nat. Hist. Soc. 39(1937)780; Noguchi, J. Hattori Bot. Lab. (= J. Hattori Shokub. Kenk.) 2(1947)56.

Neckera blanda Harv., London J. Bot. 2(1840)14; Hooker, Ic. Pl. Rar. 1 (1936) fig. 22; C. Mueller, Syn. 2(1851)185.

Trachypus blandus (Harv.) Mitt., J. Linn. Soc. Bot. Suppl. 1(1859)127; van den Bosch and van der Sande Lacoste, Bryol. Jav. 2(1864)101; Fleischer, Hedwigia 61(1920)404.

Papillaria blanda (Harv.) Jaeg., Ber. S. Gall. Naturw. Ges. 1875/76 (1877)271 = Ad. 2(1877)175; Paris, Ind. Bryol. (1897)902.

Trachypodopsis blanda (Harv.) Sedgw., J. Bombay Nat. Hist. Soc. 19, 4(1910)941, as Trachypodiopsis blanda (Harv.) Sedgw.

Trachypus blandus (Bosch et Lac. non. Harv.) Mitt. var. *thuiodes* Bosch et Lac., Bryol. Jav. 2(1864)101.

Papillaria blanda (Bosch et Lac. non Harv.) Jaeg. var. *thui(y)odes* Bosch et Lac.: Paris, Ind. Bryol. (1897)902.

Diaphanodon thuidioides Ren. et Card. syn. nov.: Renauld and Cardot, Rev. Bryol. 22(1895)33; ibid. Bull. Soc. Roy. Bot. Belg. 34, 2(1896)67; ibid. 38, 1(1900)23, 24; Paris, Ind. Bryol. Suppl. (1900)114; ibid. ed. 2, 2(1904)2; Brotherus, Nat. Pfl. 1, 3(1906)829; Dixon, J. of Bot. 50(1912)151; Brotherus, Nat. Pfl. ed. 2, 11(1925)118; Brotherus, Symb. Sin. 4(1929)76; Bruehl, Rec. Bot. Surv. India 13, 1(1931)67; Dixon, J. Bombay Nat. Hist. Soc. 39(1937)780; Noguchi, J. Jap. Bot. 14(1938)27; Herzog, Ann. Bryol. 12(1939)91; Bartram, Farl. 1, 2(1943)180; Noguchi, J. Hattori Bot. Lab. (= J. Hattori Shokub. Kenk.) 2(1947)56; Noguchi, J. Hattori Bot. Lab. 5 (1951)23.

Diaphanodon brotheri Ren. et Card., Bull. Soc. Roy. Bot. Belg. 38, 1(1900)23, 24; Paris, Ind. Bryol. ed. 2, 2(1904)2; Brotherus, Nat. Pfl. 1, 3(1906)829; Dixon, J. of Bot. 50(1912)151; Brotherus, Nat. Pfl. ed. 2, 11(1925)118; Bruehl, Rec. Bot. Surv. India 13, 1(1931)67; Herzog, Ann. Bryol. 12(1939)91.

Diaphanodon javanicus Ren. et Card. syn. nov.: Renauld and Cardot, Rev. Bryol. 28(1901)117; ibid. Bull. Soc. Roy. Bot. Belg. 41, 1(1905)75; Brotherus, Nat. Pfl. 1, 3(1906)829; Fleischer, Musci Fl. Buitenzorg 3(1908) 747; Moeller, Hedwigia 60(1919)321; Brotherus, Nat. Pfl. ed. 2, 11(1925) 118; Bruehl, Rec. Bot. Surv. Ind. 13, 1(1931)67; van Steenis, Bull. Jard. Bot. Buitenzorg 3, 13(1934)164; Froehlich, Ann. Naturh. Mus. Wien 59 (1953)90.

Diaphanodon javanicus Ren. et Card. f. *gracilior* Ren. et Card. nom. illeg.: Renauld and Cardot, Rev. Bryol. 28(1901)117; ibid. Bull. Soc. Roy. Bot. Belg. 41, 1(1905)75; Fleischer, Musci Fl. Buitenzorg 3(1908)750.

Diaphanodon javanicus Ren. et Card. f. *robustior* Ren. et Card. ex Fleisch.: Renauld and Cardot, Rev. Bryol. 28(1901)117; ibid. Bull. Soc. Roy. Bot. Belg. 41, 1(1905)75; Fleischer, Musci Fl. Buitenzorg 3(1908)749; Dixon, J. of Bot. 53(1915)290.

Pseudothuidium ceramicum Herz., Hedwigia 57(1916)239; Herzog, Hedwigia 61(1919)291; Brotherus, Nat. Pfl. ed. 2, 11(1925)117.

Trachypodopsis tereticaulis Froehl. syn. nov.: Froehlich, Ann. Naturh. Mus. Wien 59(1953)90.

Trachypus blandus (Harv.) Mitt. var. *flagellaris* Broth. nom. nud.: Renauld and Cardot, Bull. Soc. Roy. Bot. Belg. 38, 1(1900)23.

Thuidium javense Broth. nom. nud.: Fleischer, Musci Fl. Buitenzorg 3(1908)747.

Type specimens: *Diaphanodon blandus* (Harv.) Ren. et Card.: Nepal, leg. Wallich, herb. Hookerianum No. 2089; holotype in K. — *Trachypus blandus* (Bosch et Lac. non Harv.) Mitt. var. *thuiodes* Bosch et Lac.: Java, Mt. Gedeh, Tjibodas, leg. Teysmann; lectoholotype in L (No. 910.104—783). — *Diaphanodon thuidioides* Ren. et Card.: Himalaya, Bhutan, leg. Determes 1890; holotype in PC. — *Diaphanodon brotheri* Ren. et Card.: Sikkim. Kurseong, leg. Decoly and Schaul, 10-11-1898; holotype in FI. — *Diaphanodon javanicus* Ren. et Card. f. *gracilior* Ren. et Card. nom. illeg.: Java, Mt. Gedeh, Tjibodas, leg. Teysmann; lectoholotype in L (No. 910.104—

783; *cf. D. blandus* var. *blandus*, note 6). — *Diaphanodon javanicus* Ren. et Card. f. *robustior* Ren. et Card. ex Fleisch.: Java, Tjibodas, leg. Lefêbre; lectoholotype in FH. — *Pseudothuidium ceramicum* Herz.: Ceram, leg. *Stresemann*, 8-1911; holotype in L. — *Trachypodopsis tereticaulis* Froehl.: Java, Tjibodas, leg. Schiffner, 20-4-1894, No. 13331; holotype in W.

Dioicous; *slender or fairly slender*, green or brownish-green plants in more or less dense, dull mats, older parts often *blackish*. Secondary stems up to *8 cm* long, procumbent, *densely, bipinnately branched* (sometimes sparsely branched stems present), or stems up to *15 cm* long, hanging down and mostly *pinnately branched*, often *with innovations* and sometimes with flagelliform, rather laxly foliate stems. Branches mostly densely foliate, often hamate or filiform at the tips. Stem and branch leaves *dimorphous*. Stem leaves up to 1.5 mm long, appressed to erect spreading when dry, spreading to horizontally spreading when moist, from an ovate, not auriculate, somewhat decurrent base mostly somewhat abruptly, long- and narrowly acuminate, plane or slightly concave; leaf margin almost entire to strongly toothed or serrate, often partly recurved, mostly somewhat undulate; teeth erect, occasionally patent or strongly recurved. Branch leaves smaller, shorter and more gradually acuminate than the stem leaves, often *strongly concave* and carinate. Leaf margin of the branch leaves often somewhat stronger toothed or serrate than that of the stem leaves. Leaves of the flagelliform stems small, long-acuminate with a faint rib and elongate leaf cells. Leaf rib single, ending below apex. Leaf cells *isodiametric to elongate* (up to 6 times as long as wide), on both sides unipapillate over lumen (rarely with 2 papillae); border cells *not or faintly differentiated*, mostly smooth, cells towards base more elongate, smooth; alar cells present, quadrate to rectangular, smooth; cell walls rather thin to incrassate.

Sporophyte as in the diagnosis of the genus.

The present species is a highly variable one with 3 varieties which may be distinguished by the following key:

1. Leaf margin finely to moderately toothed or serrate; teeth mostly erect, rarely somewhat patent; plants either compact or not, without or with few flagelliform branches; leaf cells isodiametric to elongate.
    2. Stems up to 15 cm long, hanging down, mostly without innovations, rigid, rather sparsely pinnately or somewhat bipinnately branched **2c.** var. **ceylonensis** Zant.
    2. Stems mostly shorter, mostly procumbent and densely bipinnately branched (sometimes sparsely branched stems present), mostly with innovations **2a.** var. **blandus**
1. Leaf margin coarsely toothed; teeth patent to strongly recurved; the greater part of the plants consisting of long, flaccid branches; leaf cells somewhat elongate **2b.** var. **recurvedentatus** Zant.

2a. Diaphanodon blandus (Harv.) Ren. et Card. var. **blandus.** — Plate VI, Fig. 1a—1i. Plate VII, Map 1.

For literature and type specimens see above.

Plants mostly *compact*, in dense mats. Secondary stems up to about *8 cm* long, mostly densely *bipinnately* branched (sometimes less densely, pinnately branched stems present), procumbent, often *with innovations*. Branches densely foliate, often hamate at tips. Leaf margin almost entire to fairly strongly toothed or serrate; teeth *erect to slightly patent*. Leaf cells *isodiametric to somewhat elongate*; cell walls rather *thin to incrassate*.

INDIA: Mussoorie: Arnigadh, Bot. Gard., Bryoth. Fleischer, 19-10-1903 (FH, D. thuidioides). — Bhutan: leg. Determes. 1890 (FH, PC, D. thuidioides, isotype resp. holotype). — Calcutta ?: leg. Determes, 1897 (PC, D. thuidioides); — Sikkim: Kurseong, leg. Decoly and Schaul, 10-11-1898, No. 447, c.fr. (FI, D. brotheri, holotype); Kurseong, Punkabari, leg. Decoly, 2-9-1898 (FI, D. brotheri); Kurseong, leg. Decoly and Schaul, 2-5-1899 (FI, D. brotheri); Kurseong, Chutlakpur, leg. Decoly and Schaul, 12-1899 (FH, D. thuidioides); Kurseong, Mahaldaram forest, leg. Decoly and Schaul, 1898 (FH, D. brotheri); Kurseong, leg. Decoly and Schaul, 4-1-1900, c.fr. (FI, D. brotheri); Darjeeling, leg. Weber and Bosse, 1-1899 (FI, D. brotheri); Darjeeling, leg. Miller, 1901 (PC); herb. Hook. f. et Thoms. No. 838 (L, PC). — Simla: leg. Gollan, 29-8-1904 (K, D. thuidioides); leg. Long, 15-5-1906 (K, D. thuidioides). — Nilgiris: Uti, Sharhamhill, leg. Fleischer, 11-2-1909; Mt. Dodabetta, leg. Fleischer, 12-2-1909 (FH, L).

NEPAL: leg. Wallich, herb. Hookerianum No. 2089, c.fr. (K, Neckera blanda, holotype).

CEYLON: leg. ? (PC).

BURMA: leg. Kurz (FH).

INDONESIA: Java: Mt. Pangerango and Gedeh, Tjibodas, leg. Fleischer, 7-1898, No. 376 (FH, GRO, L, PC, U); Tjibodas, leg. Fleischer, 6-7-1898, c.fr. (FH, f. gracilior); Tjibodas-Tjibeurum, leg. Fleischer, 6-7-1898 (FH); Tjibodas, leg. Fleischer, 12-2-1913 (FH); Tjibodas, leg. Fleischer, 3-3-1913 (FH, f. robustior); Tjibodas, leg. Iwamasa (GRO); Mt. Gedeh, leg. Kuntze (FH); Tjibodas, leg. Lefêbre (FH, f. robustior, lectoholotype); Tjibodas, leg. Meyer, 13-3-1954, No. B 5773 (GRO); Tjibodas, leg. Meyer, 26-61954, No. B 5915 (GRO); Tjibodas, leg. Noerta and Dadi, 26-3-1949, No. 13 (GRO); Tjibodas, leg. Noerta and Dadi, 29-3-1949, No. 97 (GRO); Tjipanas, leg. Noerta, 14-5-1949, No. 736 (GRO); Geberbintang, Hondje Warak, leg. Noerta and Soekar, 18-7-1949, No. 2037 and 2048 (GRO); Tjibodas, leg. Nyman, 9-7-1898, No. 250 (L); Tjibodas, leg. Nyman (FH, GRO, L, f. robustior); Tjibodas, leg. Schiffner, 4-1894, No. 10836 (L); Tjibodas, leg. Schiffner, 20-4-1894, No. 13331 (W, Trachypodopsis tereticaulis, holotype); Mt. Gedeh, leg. van Steenis, 7-1928, No. 2052 (GRO, L); Mt. Salak and Gedeh, leg. Teysmann (L, No. 910.104—783, var. thuiodes, lectoholotype and No. 909.190—40, var. thuiodes); Buitenzorg, leg. Treub, 3-1897 (L, Thuidium javense); Mt. Masigit, leg. Noerta and Soekar, 9-9-1949, No. 2463 (GRO); Rawa Denok, leg. Noerta and Soekar, 8-9-1949, No. 2389 (GRO); Tjibatoe Valley, leg. Noerta and Soekar, 10-9-1949, No. 2598; Mt. Kawi, leg. Docters van Leeuwen, 17-4-1929 (FH, GRO, L); Garut, leg. Schiffner, 12-2-1894, No. 10835 (L); Mt. Tengger, leg. ?, 3-7-1858, No. 68 (L); Mt. Paldeka, leg. Korthals (L); Mt. Ardjoeno, leg. Skottsberg, 9-7-1929 (FH); Lali-Djiwa, leg. Fleischer (FH, f. robustior); Mt. Merbaboe, leg. Fleischer, 15-6-1913 (FH, f. robustior). And many other specimens from Java without further data. — Borneo: leg. Korthals (L, var. thuiodes). — Sumatra: Padang, Mt. Marapi, leg. van der Wijk, 10-6-1952, No. 1506 (GRO). — Halmaheira: leg. de Vriese (L, var. thuiodes). — Ceram: leg. Stresemann, 8-1911 (L, Pseudothuidium ceramicum, holotype). — Lombok: leg. Elbert, 3-5-1909 (L, No. 943.14—50 and 943.14—77); leg. Elbert, 11-5-1909 (L); leg. Elbert, 19-5-1909 (L, No. 943.5—40 and 943.14—52).

All specimens from Indonesia were identified as *Diaphanodon javanicus* Ren. et Card. if not otherwise indicated.

Distribution: Nepal; India (Almora, Bhutan, Sikkim, Kumaon, Assam, Mussoorie, Simla, Calcutta, Bombay, Coorg, Nilgiris); Ceylon; Yuennan (fid. Brotherus, l. c. 1929); Formosa (fid. Noguchi, l. c. 1947); Burma; Indonesia (Java, Sumatra, Borneo, Lombok, Ceram, Halmaheira).

A common variety in the mountain forests of South-East Asia.

Ecology: Mostly on trees, sometimes on rocks or growing terrestrial. Alt.: from about 900 m (Coorg, Indonesia) up to 3000 m (Himalaya, Nilgiris, Ceylon, Burma, Indonesia).

Notes. 1. The present variety is a highly variable one. The characters which may vary are a) the habit, b) the branch leaves either concave or not, c) the toothing, d) the shape of the leaves, e) the shape of the leaf cells, f) the distinctness of the papillae.

a) The plants are mostly more or less compact and densely bipinnately branched, but there occur also plants which are much less compact. Some plants, which are in general densely bipinnately branched have offshoots which are rather sparsely pinnately branched. Occasionally numerous, rather long, flagelliform stems are present (*e.g.* Sumatra, leg. van der Wijk, 10-6-1952, No. 1506, GRO). These plants therefore incline towards var. *recurvedentatus* Zant., but are clearly distinguished in having erect teeth.

b) The stem leaves are plane or faintly concave. The branch leaves on the contrary may vary from plane to strongly concave. Although the appearance of the plane and the concave leaves is quite different it is impossible to base species or even varieties or forma on this character, for it occurs fairly often that the same plant has strongly concave leaves on some branches and plane leaves on other branches. Moreover there are many plants with branch leaves which are intermediate between the plane and the concave leaves.

c) The toothing of the leaf margin may vary from almost entire to rather strong. The branch leaves are mostly somewhat stronger serrate or toothed than the stem leaves. The teeth are mostly erect, sometimes somewhat patent, and very rarely slightly recurved, but never strongly recurved as in var. *recurvedentatus* Zant.

d) The shape of the leaves may vary much. The stem leaves are mostly abruptly, long- and narrowly acuminate, whereas the branch leaves are more gradually and shorter acuminate. Sometimes the stem and the branch leaves gradually pass into each other, especially at the ends of the stems. The leaves of the flagelliform stems are mostly very long-acuminate.

e) The leaf cells are mostly more or less isodiametric, but there are many plants with elongate leaf cells (up to 6 times as long as wide) and plants with both more or less isodiametric cells and elongate cells.

f. The leaf cells vary from strongly papillose to almost smooth, but in general the papillae are clearly developed. Fairly often inconspicuous papillae are concomitant with elongate, incrassate leaf cells (*D. javanicus* f. *robustior*), but there are many exceptions.

One specimen from Nilgiris (Mt. Dodabetta, leg. Fleischer, L) is distinguished in having very distinct, *forked* papillae.

2. The plants identified as *D. brotheri* Ren. et Card. are distinguished in having a somewhat stronger toothing (teeth sometimes patent or rarely slightly recurved) and sometimes by the presence of short, more or less flagelliform branches. These plants therefore incline towards var. *recurvedentatus* Zant., but in this variety the above mentioned characters are much stronger developed, so that the plants identified as *D. brotheri* are much closer allied to var. *blandus* than to var. *recurvedentatus*.

The plants identified as *D. brotheri* gradually pass into *D. blandus* var. *blandus*, so that it is not practical to separate these plants (*cf.* also the following note).

One plant from Sikkim (Darjeeling, leg. Miller, 1901, PC) has the compact habit and the bipinnately branched stems of var. *blandus*, but there are a few rather long, flagelliform stems present and the teeth of the leaf margin are mostly patent or even somewhat recurved. This plant therefore inclines even more towards var. *recurvedentatus* than the plants identified as *D. brotheri*, but in my opinion this plant too is more allied to var. *blandus* than to var. *recurvedentatus*.

3. The somewhat slenderer plants with plane branch leaves and erect teeth from the Himalaya were described by Renauld and Cardot as the new species *D. thuidioides* Ren. et Gard. (l. c. 1895). These plants however gradually pass into *D. blandus* var. *blandus* and because the differences are not very important it is more practical not to separate these plants.

According to Herzog (l. c. 1939) *D. thuidioides* and *D. brotheri* are conspecific. He writes: "Durch die Vergleichung zahlreicher Exemplare habe ich den Eindruck gewonnen, dass die für die Trennung von *D. thuidioides* und *D. brotheri* geltend gemachten Unterschiede in Blattform und Randzähnelung sehr schwankend sind und an ein und der selben Pflanze neben einander auftreten. *D. brotheri* ist daher als Synonym zu *D. thuidioides* zu ziehen."

According to Noguchi (l. c. 1947) *D. brotheri* is conspecific with *D. blandus*.

The foregoing goes to show that the 3 species *D. blandus, D. thuidioides* and *D. brotheri* are conspecific which is in accordance with my opinion.

4. In their original description of *D. javanicus* (l. c. 1901) Renauld and Cardot mention the following differences with *D. thuidioides* a) the branch leaves concave and carinate, b) the branch leaves longer and narrower acuminate, and with *D. blandus* a) branching more regular, b) teeth erect, not patent or recurved.

These differences do indeed hold in extreme cases, but there are many intermediate forms. Moreover there occur plants having the characters of the as *D. javanicus* identified specimens on some parts of the plant as well as the characters of the as *D. thuidioides* or as *D. blandus* identified specimens on other parts.

The foregoing goes to show that it is much more practical to consider *D. javanicus, D. thuidioides, D. blandus* and *D. brotheri* (*cf.* the previous note) as one highly variable species.

Curiously Renauld and Cardot did not mention the fact that the type specimen of *D. thuidioides* is slenderer than their new species *D. javanicus*. Perhaps they did notice that this character is very unstable.

5. Within the species *D. javanicus* Renauld and Cardot distinguished 2 infraspecific taxa, *viz.* f. *gracilior* (=*Trachypus blandus* (Bosch et Lac. non Harv.) Mitt. var. *thuiodes* Bosch et Lac.) and f. *robustior* (= *Trachypus blandus* (Bosch et Lac. non Harv.) Mitt.).

The epithet *gracilior* is illegitimate because this forma is identical (according to the authors) with *D. blandus* (Bosch et Lac. non Harv.) Mitt. var. *thuiodes* Bosch et Lac. According to nomenclatural rules the name of this forma should be *D. javanicus* Ren. et Card. f. *thuiodes* (Bosch et Lac.) Ren. et Card.

The authors did not describe the f. *robustior* and it remained a nom. nud. up to 1908, when Fleischer described the forma (l. c. 1908) and the name became: *D. javanicus* Ren. et Card. f. *robustior* Ren. et Card. ex Fleisch.

According to Fleischer (l. c. 1908) f. *robustior* differs from f. *gracilior* (= f. *thuiodes*) in the following characters: a) somewhat more robust and more compact, b) leaves somewhat larger, c) branch leaves slightly narrower and longer acuminate, d) leaf cells mostly more elongate and with more incrassate cells walls.

These differences hold only in extreme cases, many plants are more or less intermediate.

As differences van den Bosch and van der Sande Lacoste only mention that f. *thuiodes* is slenderer and has filiformly attenuate branches (l. c. 1864).

6. The type specimen of *D. javanicus* f. *thuiodes* (Bosch et Lac.) Ren. et Card. (= f. *gracilior* Ren. et Card. nom. illeg.) is not Java, Mt. Gedeh, leg. Lefêbre as mentioned in the description by Renauld and Cardot (l. c. 1901), but must be one of the specimens mentioned by van den Bosch and van der Sande Lacoste in Bryol. Jav. 2(1864)101. I propose: Java, Mt. Gedeh and Salak, leg. Teysmann (L).

The type specimen of *D. javanicus* f. *robustior* Ren .et Card. ex Fleisch. must be one of the specimens mentioned by Fleischer in Musci Fl. Buitenzorg 3(1908)750. I propose: Java, Tjibodas, leg. Lefêbre (FH).

7. The type species of the genus *Diaphanodon* has hitherto been *D. thuidiodes* Ren. et Card., but now becomes *D. blandus* (Harv.) Ren. et Card., because *D. thuidioides* is conspecific with *D. blandus* and the latter was the first species published.

2b. **Diaphanodon blandus** (Harv.) Ren. et Card. var. **recurvedentatus** Zant. var. nov. — Plate VI, Fig. 1j and 1k. Plate VII, Map 2.

Type specimen: India, Sikkim, Kurseong, leg. Decoly and Schaul, 8-8-1899, No. 2564; holotype in FI, isotypes in FH and PC (all as D. brotheri).

Latin diagnosis: Var. *blandus* similis sed differt: Planta laxe caespitosa non compacte, generatim constans ex caulibus longis flaccidis flagelliformis, sine innovationibus. Folii margo asperrime dentatus, dentes magni patentes vel fortiter recurvi.

Plants in lax mats, *not compact,* the greater part consisting of long, *flaccid, flagelliform* (hanging?) stems and branches, *without innovations.* Stems rather remotely, irregularly branched, towards tips rather laxly foliate, *not hamate.* Leaves of the flagelliform stems and branches plane, long-acuminate. Leaf margin *very coarsely* toothed; *teeth large, patent to strongly recurved.* Leaf cells more or less elongate.

I have only seen the type specimen.

Distribution: India: Sikkim only.

Ecology: Alt.: 2000 m.

Notes. 1. Although the present variety is well distinguished from the other varieties there occur some intermediate forms with var. *blandus* (see there, note 2).

Notwithstanding the occurrences of these intermediate forms it is in my opinion justified to consider the present variety to be a separate one for the following reasons:

a. the very great difference in their habit and toothing,

b. because I have not found a gradual passing from the one variety into the other; the intermediate forms stand quite isolated and are easily recognizable.

2. In herb. FI there is a specimen present under the name of *Trachypus blandus* (Harv.) Mitt. var. *flagellaris* Broth. nom. nud., leg. Decoly and Schaul, 10-11-1898, No. 447, see also Renauld and Cardot, Bull. Soc. Roy. Bot. Belg. 38, 1(1900)23. The plant in the capsule however has no flagelliform stems or branches and cannot be separated from *D. blandus* var. *blandus*.

Perhaps the new variety *recurvedentatus* Zant. is the same plant Brotherus meant by var. *flagellaris* Broth. nom. nud. and the plants in the capsules may have been shifted.

2c. **Diaphanodon blandus** (Harv.) Ren. et Card. var. **ceylonensis** Zant. var. nov. — Plate VII, Map 2.

Fleischer, Musci Fl. Buitenzorg 3(1908)750, as Trachypus blandus (Harv.) Mitt.

Type specimen: Ceylon, Horton Plaines, Mt. Kirigalpota, leg. Herzog, 2-1906; holotype in L.

Latin diagnosis: Var. *blandus* similis sed differt: Planta laxe caespitosa non compacte; caules usque ad 12 cm longi, rigidi plerumque penduli pinnate ramosi, plerumque sine innovationibus. Folii margo leviter dentatus, dentes erecti.

Plants in rather lax mats, *not compact*. Stems rather long, up to *12 cm*, rigid, hanging down, rather *remotely pinnately* or hardly bipinnately branched, *mostly without innovations*. Leaf margin rather faintly toothed; *teeth erect*. Leaf cells somewhat elongate with incrassate cell walls.

Ceylon: Horton Plaines, Mt. Kirigalpota, leg. Herzog, 2-1906, c.fr. (L, holotype); leg. ?, ex herb. Peradeniyagarden (PC); without further data (FH, D. blandus, f. gracilior).

Distribution: Ceylon only.

Ecology: On shrubs at about 2500 m altitude.

Notes. 1. The present variety is closely allied to var. *blandus*, but differs mainly in having long, up to 12 cm, rigid, remotely pinnately or hardly pinnately branched stems.

2. Of the Ceylonese plants Fleischer says (l. c.): "Die Originalpflanzen von *Trachypus blandus* Mitt. aus Ceylon ex herb. Peradeniyagarden unterscheiden sich (from *D. javanicus*) durch sehr zerstreut einfach- oder fiedrig-beästete, bis 8 cm lange, hängende Stengel und festere Blätter mit dickwandigeren Blattzellen; ausserdem fehlen die charakteristischen, einfach sprossenden Stengelinnovationen. Diese Art ist aus Nepal, Sikkim-Himalaya, Khasia, Neilgherris, Süd-Indien bei Coorg bekannt. Die Sikkimpflanze unterscheidet sich von der Ceylonpflanze durch weniger papillöse Zellen (fid. Cardot)."

From the above it follows that, according to Fleischer, the plants from

Ceylon and those from the other regions mentioned were identical (apart from the difference in the distinctness of the papillae).

Most of the specimens from Ceylon I saw (among them the plant mentioned by Fleischer, ex Peradeniyagarden) deviate from the plants from the other regions, *e. g.* No. 838 of herb. Hook. f. et Thoms., which specimen Renauld and Cardot considered representative for *D. blandus, cf.* Bull. Soc. Roy. Bot. Belg. 38, 1(1900)23. The differences I found are mainly exactly those differences mentioned by Renauld and Cardot, Rev. Bryol. 28(1901)117, and by Fleischer (l. c.) between *D. blandus* and *D. javanicus*. From this fact it follows that Fleischer as well as Renauld and Cardot meant with *D. blandus* a plant which has the characters of the new variety *ceylonensis* Zant., which is not quite exact.

The reason why Fleischer and Renauld and Cardot made this mistake is probably the fact that none of these authors have seen the actual type of *D. blandus.* Fleischer probably considered the specimen from Ceylon, which afterwards became the type specimen of the new var. *ceylonensis* Zant., representative for *D. blandus,* and Renauld and Cardot the above mentioned No. 838 of herb. Hook. f. et Thoms., which plant was identified by Mitten as *Neckera blanda* (= *D. blandus*). In point of fact this is correct, but No. 838 of herb. Hook. f. et Thoms. has offshoots which are rather sparsely, mostly only pinnately branched and it therefore inclines towards var. *ceylonensis* Zant., but the greater part of the specimen is compact and bipinnately branched as contrasted with var. *ceylonensis.*

Unless there become many intermediate forms known I consider the less compact, mostly only pinnately branched specimens from Ceylon as to be a separate variety for the following reasons:

a. the very great difference in habit,

b. because var. *ceylonensis* is only found in Ceylon, although I saw many more specimens from the other regions than from Ceylon.

4. **Pseudospiridentopsis** (Broth.) Fleisch.

Brotherus, Nat. Pfl. 1, 3(1906)832 (as a section of the genus Trachypodopsis); Fleischer, Musci Fl. Buitenzorg 3(1908)730; Brotherus, Nat. Pfl. 1, 3(1909)1228; ibid. ed. 2, 11(1925)119; Bartram, Philipp. J. Sc. 68(1939)195.

Diocious ?; plants *robust or very robust,* yellowish-green to yellowish-brown, mostly *tinged with brown or black* (except at the tips). Stems rigid, up to *15 cm* long, mostly somewhat flexuose, ascending, *simple or remotely* branched, mostly densely foliate. Central strand present or wanting, but never well developed. Leaves up to *9 mm* long, *horizontally spreading,* from an *erect, sheathing,* broadly cordate, *auriculate* base *long- and narrowly,* gradually or somewhat abruptly acuminate; leaf margin plane, moderately serrate near apex, serrulate below down to base. Leaf rib single, ending some distance below apex, sometimes forked above. Leaf cells *oval to rhomboidal,* about 2—5 times as long as wide, on both sides *unipapillate* over lumen or smooth, border cells mostly somewhat more elongate, smooth, cells towards base linear, smooth, cells in the auricles shorter, smooth; alar cells absent; cell walls mostly *very incrassate,* strongly pitted.

Inner perichaetial leaves much smaller than the stem leaves. Seta *3 mm* long, thick, *smooth.* Capsule *ovoid,* erect, without neck, slightly contracted below the mouth when dry. Lid conical, obliquely rostrate. Peristome double. Exostome teeth 16, lanceolate-subulate, with a zigzag median line, papillose towards the ends. Endostome teeth on a high basal membrane, about the same length as the exostome teeth, lanceolate, papillose. *Cilia present.* Calyptra and spores not known.

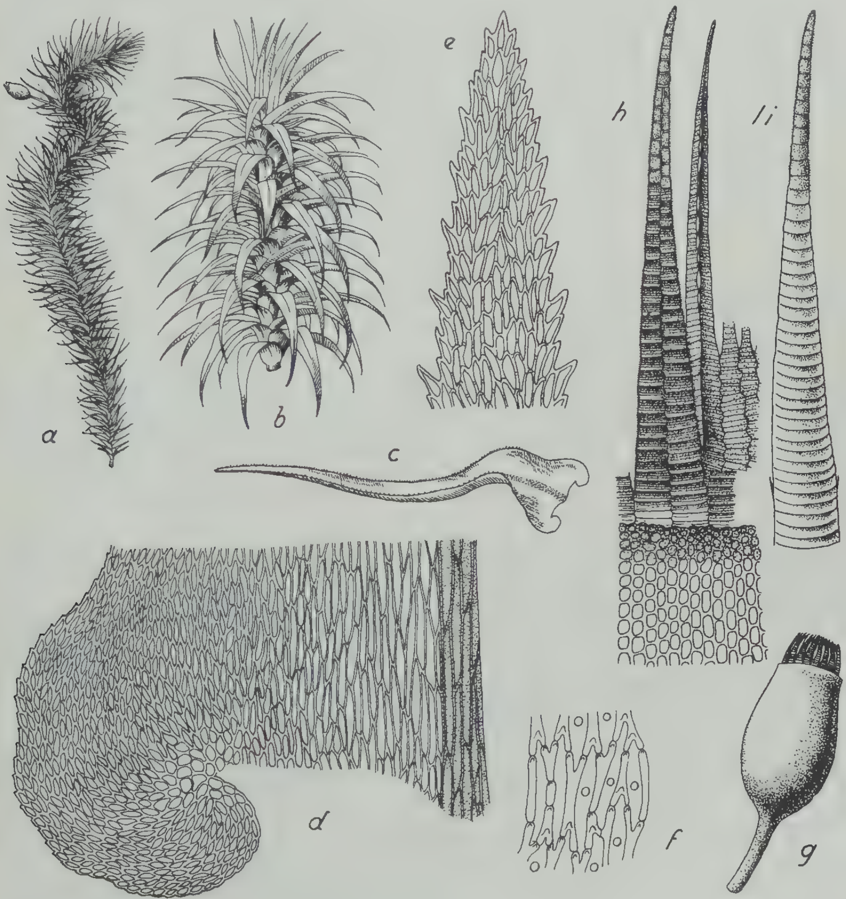


Plate VIII. — *Pseudospiridentopsis horrida* (Card.) Fleisch., a habit (1/3), b part of stem (3/1), c leaf (7/1), d auricle (75/1), e leaf apex (100/1), f leaf cells (200/1), g capsule (8/1), h peristome (100/1), i exostome tooth, inner face (100/1). (After Brotherus, Nat. Pfl. ed. 2, 11 (1925)120).

History of the genus up to the present paper.

The genus was founded by Fleischer when he raised the section *Pseudo-Spiridentopsis* Broth. of the genus *Trachypodopsis* to a separate genus (l. c. 1908).

Type species is the only species *Pseudospiridentopsis horrida* (Card.) Fleisch.

In 1947 Noguchi added the forma *P. horrida* (Card.) Fleisch. f. *laxifolia* Nog. to the genus, J. Hattori Bot. Lab. (= J. Hattori Shokub. Kenk.) 2(1947)56.

Relationships.

The genus *Pseudospiridentopsis* is quite different from the other genera of the family. The sporophyte is related to that of *Duthiella* on account of its having a smooth seta and because of the presence of cilia and a high basal membrane of the inner peristome; it has however a short seta as in *Diaphanodon*.

The gametophyte differs from the other genera of the family in its robust or very robust habit (except for *Trachypus bicolor* Reinw. et Hornsch. var. *bicolor*) and its long- and narrowly acuminate, reflexed leaves.

Geographical distribution and ecology.

Herzog, Geogr. Moose (1926)143, 266, 342, 351.

See further below.

Note. I have not seen the sporophyte but described it from the figure given by Brotherus (l. c. 1925) and the description by Cardot, Beih. Bot. Centralbl. 19, 2(1905)118, in so far as this was possible.

1. **Pseudospiridentopsis horrida** (Card.) Fleisch. — Plate VIII. Plate VII, Map 3.

Pseudospiridentopsis horrida (Card.) Fleisch., Musci Fl. Buitenzorg 3(1908)730; Brotherus, Nat. Pfl. 1, 3(1909)1228; Brotherus, Philipp. J. Sc. 5, 2, C, Bot. (1910)154; ibid. 8, 2, C, Bot. (1913)80; Brotherus, Nat. Pfl. ed. 2, 11(1925)120; Brotherus, Symb. Sin. 4(1929)77; Bruehl, Rec. Bot. Surv. India 13, 1(1931)68; van Steenis, Bull. Jard. Bot. Buitenzorg 3, 13(1936)164; Horikawa, Bot. Mag. Tokyo 50(1936)384; Dixon, Not. Roy. Bot. Gard. Edinburgh 19(1938)292; Bartram, Philipp. J. Sc. 68(1939)195; Horikawa in Asahina, Nippon Inkwasyokubutu Dukan (1939)953 (not seen); Noguchi, J. Hattori Bot. Lab. (= J. Hattori Shokub. Kenk.) 2(1947)55; Sakurai, Musc. Jap. (1954)101.

Meteorium horridum Mitt. ex Card.: Cardot, Beih. Bot. Centralbl. 19, 2(1905)118.

Trachypodopsis horrida (Card.) Broth., Nat. Pfl. 1, 3(1906)832.

Type specimen: Formosa, Mt. Taitum, leg. Faurie, 1903, No. 164; type probably lost. Neotype: Formosa, Prov. of Taihoku, Mt. Taikei, leg. Suduki, 16-8-1925 (H).

Diagnosis as in the description of the genus.

FORMOSA: Prov. of Taihoku, Mt. Taikei, leg. Suduki, 16-8-1925 (H, neotype).

PHILIPPINE ISLANDS: Luzon, Subprov. of Benguet, leg. Merrill, 5-1911, No. 7859 (H); Abra-Lepanto, Mt. Lamunan, leg. Micholitz, 6-4-1910 (H).

INDIA: Assam, herb. Griffith, No. 846 (PC).

Distribution: Himalaya (Bhutan); Assam; Yuennan (fid. Brotherus, l. c. 1929); Formosa; Luzon; Japan: isle of Yakushima (fid. Horikawa, l. c. 1936).

Ecology: On trees, limestone cliffs and granitic ground from 800 up to 2700 m altitude.

Note. The sporophyte is only known of one specimen from Bhutan which I have not seen.

Pseudospiridentopsis horrida (Card.) Fleisch. f. **laxifolia** Nog.

Noguchi, J. Hattori Bot. Lab. (= J. Hattori Shokub. Kenk.) 2(1947)56.

Type specimen: Formosa, leg. Noguchi, 8-1932, No. 6069 (not seen).

Differs from the typical form in being somewhat *less robust*, not tinged with brown or black and especially in being *laxly foliate.*

FORMOSA: Prov. of Taihoku, Mt. Taikei, leg. Noguchi, 23-8-1932, No. 6067 (herb. Noguchi).

Distribution: Formosa only.

Ecology: No data.

Notes. 1. I have not seen the type specimen, but another specimen which, according to Noguchi is identical with the type.

2. In how far the above mentioned differences with the typical form are stable ones or have been caused by an aberrant habitat will have to be investigated with the help of further material, but because hitherto no intermediate forms have been found it is in my opinion justified to consider the plants as to be a separate forma.

5. **Duthiella** C. Muell. ex Broth.

Brotherus, Nat. Pfl. 1, 3(1908)1009; ibid. ed. 2, 11(1925)122; Bartram, Philipp. J. Sc. 68(1939)197.

Dioicous; medium sized to fairly robust, green or yellowish-green (when old often brownish) plants in dull or somewhat glossy mats. Primary stems creeping, with tufts of blackish rhizoids and more or less scale-like lower leaves. Secondary stems procumbent or somewhat ascending, irregularly, more or less pinnately or slightly arborescently branched. Secondary stems and branches more or less densely, either complanately foliate or not. Central strand present or wanting, but never well developed. Leaves spreading to erect spreading, occasionally appressed when dry, horizontally spreading when moist, from 1 up to 4 mm long, plane or somewhat longitudinally plicate, often crisped near apex, from an ovate or broadly ovate, *not or faintly auriculate* base, more or less gradually, shorter or longer acuminate; leaf margin faintly, but distinctly to strongly serrate. Stem leaves sometimes slightly shorter acuminate than the branch leaves. Leaf rib single, ending below apex. Leaf cells more or less isodiametric to elongate-hexagonal or linear, on both sides *unipapillate* or *seriately papillate over lumen* (occasionally indistinctly papillate), more elongate and smooth towards base; border cells either differentiated or not, mostly smooth; alar cells present, but often few, quadrate to rectangular, smooth; cells walls mostly rather thin, often somewhat sinuose, occasionally incrassate and pitted.

Sporophyte lateral on the secondary stems and branches. Seta *1.5*—

5 cm long, erect, *smooth* (rarely slightly mamillose in the upper part), brown, reddish or yellowish, contorted when dry. Vaginula cylindrical, smooth, with a number of archegonia and numerous paraphyses; archegonia bottle-shaped, long-necked, brownish-red. Perichaetial leaves pale, from a sheathing base long- and narrowly acuminate, margin entire to faintly toothed, rib indistinct, the outer leaves small, shorter acuminate, cells elongate to linear, about 4—10 times as long as wide, thin-walled, smooth, pellucid. Capsule curved, *oblong-cylindrical, inclined or horizontal,* about 2—2.5 mm long, with a short neck, slightly contracted below the mouth when dry, reddish, with stomata; exothecium cells quadrate or hexagonal to rectangular, in longitudinal rows, slightly incrassate, smaller towards mouth. Lid conical, obliquely rostrate. Peristome double. Exostome teeth 16, on a low basal membrane, lanceolate-subulate, yellowish, transversally striate on outer face, with a zigzag median line, trabeculate, especially in the upper part, papillose towards the ends. Endostome teeth 16, on a high, smooth to strongly papillose basal membrane, somewhat shorter than the exostome teeth, lanceolate-subulate, papillose. *Cilia 3,* nodose, papillose, somewhat shorter than the endostome teeth. Calyptra *cucullate, naked.* Spores *small,* globular, smooth, up to 12 μ in diameter, yellowish.

History of the genus up to the present paper.

From a nomenclatural point of view the genus *Duthiella* C. Muell. ex Broth. was founded by Brotherus, Nat. Pfl. 1, 3(1908)1009, within the family of the *Leskeaceae*, with two species *D. wallichii* (Mitt.) Broth. and *D. flaccida* (Card.) Broth. He did not indicate a type species. According to Reimers, Hedwigia 76(1937)288, the type species must be *D. emodi* C. Muell. ex Reim. described by himself and by Brotherus erroneously identified with *Hypnum wallichii* Hook. ex Schwaegr. = *D. wallichii* (Mitt.) Broth., and not one of the species mentioned by Brotherus (all according to Reimers), which is however in contravention of the nomenclatural rules and thus illegitimate. I propose *D. wallichi* as lectotype species of the genus, because for the description of the genus Brotherus used the sporophyte and very likely also the gametophyte of this species.

The genus has been transferred from the family of the *Leskeaceae* to the family of the *Trachypodaceae* by Fleischer in 1923, Musci Fl. Buitenzorg 4(1923)1495.

The following species and varieties have successively been added to the genus:

D. complanata Broth.	Philipp. J. Sc. 5, 2, C, Bot. (1910)157.
D. japonica Card.	Bull. Soc. Bot. Genève 2, 3(1911)283.
D. pellucens Thér.	Bull. Géogr. Bot. 21(1911)271.
D. speciosissima Card.	Bull. Soc. Bot. Genève 2, 5(1913)317.
D. rigida Broth.	Sitzungsber. Akad. Wiss. Wien 1, 131(1922)218.
D. perpapillata Broth.	Symb. Sin. 4(1929)78.
D. lacustris Reim. et Sak.	Bot. Jahrb. 64(1931)543.
D. formosana Nog.	Trans. Nat. Hist. Soc. Formosa 24(1934)469.

D. robusta Nog.	Trans. Nat. Hist. Soc. Formosa 24(1934)470.
D. rivicola Sak.	Bot. Mag. Tokyo 50(1936)264.
D. myuriiformis Sak.	Bot. Mag. Tokyo 50(1936)518.
D. emodi Reim.	Hedwigia 76(1937)289.
D. mussooriensis Reim.	Hedwigia 76(1937)289.
D. japonica Card. var. *pallida* Sak.	Bot. Mag. Tokyo 51(1937)796.
D. guilbertii Thér. et P. Vard.	Rev. Bryol. Lich. 15(1946)146.
D. flaccida (Card.) Broth. var. *gigantea* Nog.	J. Hattori Bot. Lab. (= J. Hattori Shokub. Kenk.) 2(1947)61.
D. media Nog.	J. Hattori Bot. Lab. (= J. Hattori Shokub. Kenk.) 2(1947)61.
D. brassii Bartr.	Britt. 9, 1(1957)45.

Relationships.

Fleischer, Hedwigia 45(1905)64; Fleischer, Musci Fl. Buitenzorg 3 (1908)729, 849; ibid. 4(1923)1495; Reimers, Hedwigia 76(1937)211.

When Brotherus founded the genus *Duthiella* he incorporated it within the family of the *Leskeaceae* (group of the *Thuidieae*; afterwards raised as a family by Fleischer (l. c. 1923)) on account of the resemblance of the sporophyte, probably mainly due to the presence of a high basal membrane of the endostome, well developed endostome teeth and cilia, elongate seta and inclined capsule. In agreement herewith Fleischer states (l. c. 1905 and 1908): "Die im Himalaya vorkommende Gattung *Duthiella* Geh. et C. Muell. nähert sich im Blattcharacter sehr den *Trachypodaceen*, doch ist sie habituell (durch Sporogontragenden Hauptstengel) und durch die geneigte Kapsel auf langer Seta mit Hypnumperistom so abweichend, dass sie besser zu den *Leskeaceen* gestellt wird."

There are however some objections to incorporating the genus *Duthiella* within the family of the *Leskeaceae*, *e. g.* on account of the great difference in the mode of branching and the absence of paraphyllia. Some species of *Duthiella* closely resemble some species of the genus *Trachypodopsis*, on account of which Fleischer included the genus *Duthiella* afterwards in the family of the *Trahypodaceae* (l. c. 1923). Brotherus, Nat. Pfl. ed. 2, 11(1925)122, and Herzog, Geogr. Moose (1926)143, follow Fleischer in this conception.

The preceding goes to show that the place which is given to the genus *Duthiella* depends on the question whether one gives greater importance to the gametophyte or to the sporophyte when separating the taxa.

The place of *Duthiella* given by Fleischer within the family of the *Trachypodaceae* is justified on account of the very close resemblance between some *Duthiella* and some *Trachypodopsis* species with regard to the gametophyte, but in my opinion it is doubtful whether this resemblance is of phylogenetical value.

In general the genus *Duthiella* is well distinguished from most other genera, also when not in fruit. There is however a slight resemblance to some *Meteoriaceae*, particularly to the *Aërobryopsis* species with oval-hexagonal leaf cells, *e. g. A. leptosigmata* (C. Muell.) Fleisch., but these plants are distinguished in having longer acuminate, faintly toothed leaves. Moreover the sporophytes are quite different.

The gametophytes of the species which belong to the section *Duthiella* (see below) bear close resemblance to some species of the genus *Trachypodopsis*, but are always recognizable on account of the absence of leaf auricles, except for *D. speciosissima* Card. and *D. formosana* Nog. which species have mostly small auricles (*cf. Trachypodopsis serrulata* var. *serrulata*, note 4). Moreover the leaves in *Trachypodopsis* are mostly acuminate and stronger longitudinally plicate than in *Duthiella*. The sporophytes are quite different.

Relationships within the genus.

Within the genus *Duthiella*, two infrageneric taxa (sections) can be distinguished based on the number of papillae which occur over the lumina of the leaf cells, Reimers, Hedwigia 76(1937)289.

Section 1: Duthiella (= Unipapillatae Reim. nom. illeg.); leaf cells on both sides unipapillate over lumen, with 6 species:

1. *D. wallichii* (Mitt.) Broth.
2. *D. myuriiformis* Sak.
3. *D. declinata* (Mitt.) Zant.
4. *D. robusta* Nog.
5. *D. formosana* Nog.
6. *D. speciosissima* Card.

Section 2: Pluripapillatae Reim.; leaf cells seriately papillate over lumen, with 1 species:

7. *D. flaccida* (Card.) Broth.

Regarding the sporophyte there is also a difference between the two sections: the basal membrane of the endostome in the section *Duthiella* is smooth or faintly papillose and in the section *Pluripapillatae* Reim. strongly papillose.

In how far this character is a stable one will have to be investigated with the help of further material.

According to Reimers, Hedwigia 76(1937)289, *D. rigida* Broth. and *D. pellucens* Thér. belong to the section *Duthiella* (= Unipapillatae Reim. nom. illeg.), the two species are however conspecific with *D. flaccida* (Card.) Broth. (as will be shown below) and consequently do not belong to the section *Duthiella*, but to that of the *Pluripapillatae* Reim.

Excluded species.

Duthiella guilbertii Thér. et P. Vard. has been transferred to the genus *Trachypodopsis* as **T. serrulata** (P. Beauv.) Fleisch. var. **guilbertii** (Thér. et P. Vard.) Zant. comb. nov.

Geographical distribution.

Herzog, Geogr. Moose (1926)143, 266, 269, 342, 351.

The distribution of the genus is restricted to South-East Asia.

D. wallichii (Mitt.) Broth.	Himalaya, Yuennan ?, Java.
D. myuriiformis Sak.	Japan.

D. declinata (Mitt.) Zant.	Himalaya, Szechwan, Philippine Islands.
D. robusta Nog.	Formosa.
D. formosana Nog.	Formosa.
D. speciosissima Card.	Japan, Sikang (China).
D. flaccida (Card.) Broth.	Japan, Formosa, Philippine Islands, New Guinea, China.

Conspicuous is the absence of the genus in Southern India, Ceylon, Malay Peninsula, Burma, Siam, Laos etc. and the occurrence of only a few localities in Indonesia (Java).

Duthiella flaccida (Card.) Broth. (which is also the most variable species of the genus) seems to occur more frequently than the other species.

Ecology.

Mostly on trees or growing terrestrial, occasionally on rocks and rarely in running water. On the continent up to 3100 m altitude, of the other regions only a few data about the altitude: Japan 100 m; Java 750—1500 m; New Guinea 1370 m.

The genus belongs to the South-East Asian mountain forest flora, Herzog, Geogr. Moose (1926)266, with radiation into Japan, Formosa, Philippine Islands, Java and New Guinea.

Key to the species

1. Leaf cells unipapillate over lumen (rarely with 2 or 3 papillae or smooth).
  2. Plants medium sized; leaves 1—3 mm long, not auriculate.
    3. Cells in the upper part of the leaf more or less elongate, 1.5—6 times as long as wide; cell walls often somewhat sinuose; leaves distinctly bordered, margin strongly serrate . . . . 3. **D. declinata** (Mitt.) Zant.
    3. Cells in the upper part of the leaf more or less isodiametric or up to 2.5 times as long as wide, but then the leaf base broadly ovate and the seta about 1.5 cm long; cell walls not sinuose; leaves either bordered or not, margin faintly to moderately serrate.
      4. Cells in the upper part of the leaf more or less isodiametric, 10—22 μ in diameter; leaf base ovate; seta 3—4 cm long, smooth 1. **D. wallichii** (Mitt.) Broth.
      4. Cells in the upper part of the leaf 1.5—2.5 times as long as wide, 18—30 μ long; leaf base broadly ovate; seta about 1.5 cm long, in the the upper part faintly mamillose . . . . 2. **D. myuriiformis** Sak.
  2. Plants fairly robust; leaves 2.5—4 mm long, faintly auriculate or without auricles, but then the cell walls incrassate and pitted; leaf cell elongate to linear, 3—10 times as long as wide.
    5. Leaves not auriculate; leaf margin moderately serrate, border cells not differentiated; cell walls incrassate, pitted . . . . 4. **D. robusta** Nog.
    5. Leaves mostly faintly auriculate; leaf margin moderately to rather strongly serrate, border cells more or less differentiated; cell walls not incrassate.
      6. Leaves not appressed when dry; alar cells few; seta about 5 cm long 6. **D. speciosissima** Card.
      6. Leaves mostly appressed when dry; alar cells rather numerous; seta about 2.5 cm long . . . . 5. **D. formosana** Nog.
1. Leaf cells seriately papillate over lumen . . . 7. **D. flaccida** (Card.) Broth.

1. **Duthiella wallichii** (Mitt.) Broth. — Plate IX, Fig. 1. Plate X, Map 1.

Duthiella wallichii (Mitt.) Broth., Nat. Pfl. 1, 3(1908)1010; ibid. ed. 2, 11(1925)123; Herzog, Hedwigia 65(1925)163; Bruehl, Rec. Bot. Surv.

India 13, 1(1931)68; Reimers, Hedwigia 76(1937)288; Dixon, Not. Roy. Bot. Gard. Edinburgh 19(1938)292.

Hypnum wallichii Hook. ex Schwaegr., homonym illeg. [non Hypnum wallichii Brid., Bryol. Univ. 2(1827)416] : Schwaegrichen, Spec. Musc. Suppl. 3, 1(1827) tab. 219; C. Mueller, Syn. 2(1851)464.

Leskea wallichii Mitt., J. Linn. Soc. Bot. Suppl. 1(1859)132.

Pseudoleskea wallichii (Mitt.) Jaeg., Ber. S. Gall. Naturw. Ges. 1877/78 (1880)475 = Ad. 2(1880)739; Paris, Ind. Bryol. (1898)1039; ibid. ed. 2, 4(1905)108.

Hypnum s(t)igmatodiction C. Muell. nom. nud.: van den Bosch and van der Sande Lacoste, Bryol. Jav. 2(1864)100; Fleischer, Musci Fl. Buitenzorg 3(1908)731.

Type specimen: Nepal, leg. Wallich, herb. Hookerianum No. 3508; holotype in K.

Dioicous; *medium sized*, green or yellowish-green plants in *dull* mats. Secondary stems procumbent or somewhat ascending, irregularly or more or less pinnately branched, not or somewhat complanately foliate. Leaves spreading when dry, horizontally spreading when moist, up to 3 mm long, plane or faintly longitudinally plicate, often crisped near apex, from an ovate, not auriculate base more or less gradually acuminate; leaf margin *faintly to moderately serrate.* Leaf rib single, ending below apex. Leaf cells *quadrate to rhomboic*, isodiametric to slightly elongate, *10—22 μ* long, towards base more elongate, on both sides *unipapillate* over lumen, basal cells smooth; border cells either somewhat elongate or not, mostly smooth; alar cells few, quadrate to rectangular, smooth; cell walls rather thin, *not sinuose.*

Sporophyte as in the diagnosis of the genus. Seta about *3—4 cm* long. Basal membrane of the endostome *faintly papillose.*

Nepal: leg. Wallich, herb. Hookerianum No. 3508, c.fr. (K, holotype).

India: Himalaya: herb. Ind. Or. Hook. f. et Thoms. No. 1017, c.fr. (L, No. 910.132—956, Trachypus declinatus and No. 910.110—1357, Pseudoleskea wallichii).

Indonesia: Java: Mt. Pangerango, Tugu, leg. Meyer, 13-3-1952, No. B 591 (L); Gegerbintang, Hondje Warak, leg. Noerta and Soekar, 18-7-1949 (GRO); leg. Zip(p)elius (H, Trachypodopsis declinata); leg. ? (L, Trachypodopsis declinata); leg. ? (L, No. 910.132—957 and No. 898.134—56, Trachypus declinatus).

Without locality: leg. Webster, No. 72b (BM).

Distribution: Nepal; Himalaya; Yuennan? (*cf.* Herzog, l. c. 1925); Java.

Ecology: On trees and on rocks. Alt.: 700—1500 m (Java) and 2400—3000 m (Himalaya).

Notes. 1. A fairly variable species concerning a) the shape of the leaves, b) the distinctness of the leaf border and c) the shape of the cells in the lower part of the leaf.

a) and c) Most plants from Java are distinguished in having a longer acuminate, more crisped leaf apex and more elongate cells in the lower part of the leaf. There occur however intermediates. All these plants incline therefore somewhat towards *D. declinata* (Mitt.) Zant., but confusion is impossible for *D. declinata* has an even longer acuminate leaf apex, more elongate leaf cells, especially in the upper part of the leaf and a very distinct leaf border. Moreover the general aspect is quite different.

One specimen from Java (L, No. 910.132—957) has in addition to the above mentioned differences also small auricles and inclines therefore somewhat towards *D. speciosissima* Card. (and even towards *Trachypodopsis serrulata* (P. Beauv.) Fleisch. var. *serrulata,* see there, note 4), but is clearly differentiated in having almost isodiametric cells in the upper part of the leaf and a less strongly serrate leaf margin.

b) The distinctness of the leaf border may vary a great deal, also on leaves of the same plant. Most plants namely have at the same time scarcely bordered as well as strongly bordered leaves. It may happen that one half of a leaf is clearly bordered and the other half not or hardly so.

2. The plants which Fleischer described under the name of *Trachypodopsis declinata* (Mitt.) Fleisch., Musci Fl. Buitenzorg 3(1908)731, and those described by van den Bosch and van der Sande Lacoste under the name of *Trachypus declinatus* Mitt., Bryol. Jav. 2(1864)100, actually belong here. Van den Bosch and van der Sande Lacoste described the sporophyte from No. 1017 from herb. Ind. Or. Hook. f. et Thoms., which plant however is not *Trachypus declinatus* Mitt., but *Duthiella wallichii* (Mitt.) Broth. With the help of another specimen they described the gametophyte, which specimen belonged very likely also to *Duthiella wallichii* for the following reasons:

a. In the description the authors say nothing about the leaf border, which in *D. declinata* (Mitt.) Zant. is very distinct.

b. About the leaf cells they say: “cellulis minutis rotundis”, which is true for *D. wallichii,* but not for *D. declinata,* which species has elongate leaf cells.

c. In herb. L there is a specimen (No. 910.132—957) under the name of *Trachypus declinatus* Mitt. from the herb. of van der Sande Lacoste, which is in reality *Duthiella wallichii* (Mitt.) Zant.

From these facts in my opinion it follows that van den Bosch and van der Sande Lacoste have confused *D. declinata* (Mitt.) Zant. (= *Trachypus declinatus* Mitt.) with *D. wallichii* (Mitt.) Broth.

The confusion about the sporophyte was observed by Fleischer where he writes, Musci Fl. Buitenzorg 3(1908)733: “Die Diagnose der Sporogone in Bryol. jav. II, p. 101, scheint auf einem Irrtum zu beruhen und bezieht sich vielleicht auf *Pseudoleskea (Leskea) Walichii* (Mitt.) Sieb., welches in herb. Ind. Or. Hook. f. et Thoms. unter No. 1017 liegt”, but with regard to the gametophyte he makes the same mistake as van den Bosch and van der Sande Lacoste. Although I am not positively sure I have actually seen the specimens from which Fleischer described *Trachypodopsis declinata* (Mitt.) Fleisch. in my opinion it is certain that actually he had got to do with *D. wallichii* (Mitt.) Broth., for the following reasons:

a. In the description Fleischer says i. a.: “Secundäre Stengel locker, sehr zerstreut fiedrig beästet, — Fiederäste etwas verflacht beblättert. Blätter trocken wie feucht ausgebreitet abstehend, —”, etc.

b. In the figure isodiametric cells have been drawn and the general habit of the plant and the leaf border cells in the figure are exactly the same as those of *D. wallichii* (Mitt.) Broth.

c. In herb. L there is a specimen (No. 898.134—56) which has been transferred by Fleischer from *Trachypus declinatus* Mitt. to the genus *Trachypodopsis,* which specimen is actually *D. wallichii* (Mitt.) Broth.

The characters mentioned under a and b apply to *D. wallichii* and not to *D. declinata.*

The confusion may have been caused by the fact that the plants of *D. wallichii* from Java incline slightly towards *D. declinata* (*cf.* note 1).

Which points even more clearly to the fact that the two species have got mixed up is that the true *D. declinata* has never been found in Indonesia.

3. *Duthiella wallichii* (Mitt.) Broth. has not only been confused with *D. declinata* (Mitt.) Zant. = *Trachypodopsis declinata* (Mitt.) Fleisch., but also with *D. flaccida* (Card.) Broth.

The specimens from herb. Strachey et Winterbottom No. 78 (K), also mentioned by Jaeger (l. c. 1880), Kumaon and those from herb. Griffith No. 53 (K), Bhutan, all identified as *Hypnum wallichii* Hook. ex Schwaegr. do not belong to *D. wallichii* but to *D. flaccida* (Card.) Broth.

The specimen from Tosa (Japan), ex coll. Cono, leg. 11-10-1904 (H), identified as *D. wallichii* (Mitt.) Broth. is actually *D. flaccida* (Card.) Broth.

4. The figure of *D. wallichii* (Mitt.) Broth. given by Brotherus (l. c. 1908 and 1925) is not characteristic since the cells of the leaf border are mostly much less distinctly differentiated than is drawn. According to Reimers (l. c. 1937) the above mentioned figure does not exactly fit *D. wallichii* but rather *D. mussooriensis* Reim. = *D. declinata* (Mitt.) Zant., which however cannot be true for *D. mussooriensis* has elongate leaf cells.

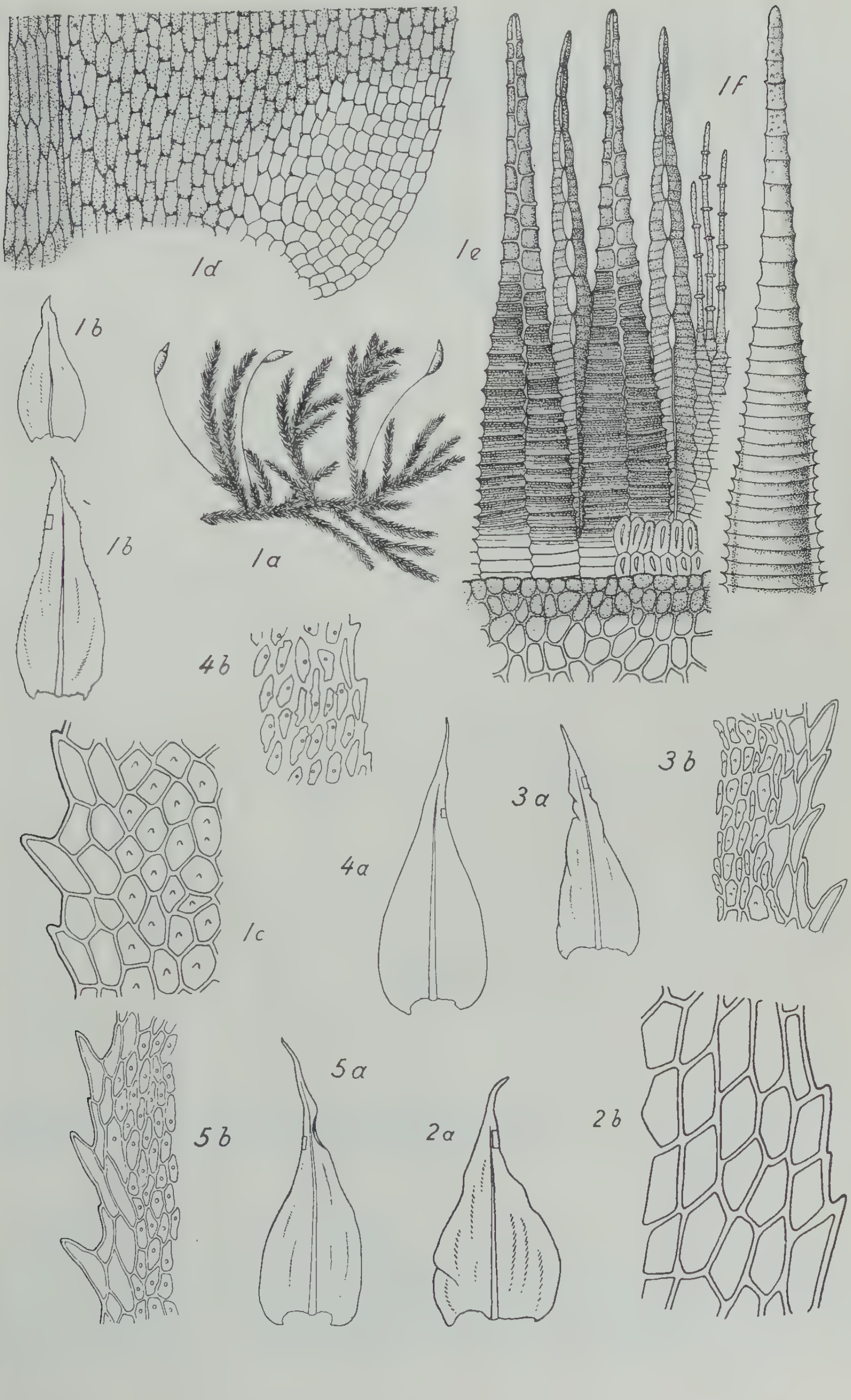
5. In his description of *D. wallichii* (Mitt.) Broth. Reimers says (l. c. 1937): "marginibus minute denticulatis" and Schwaegrichen in his original description says (l. c. 1827): "grosse et argute serrata". In reality the leaf margin is moderately serrate, so is the type specimen and the only other specimen seen by Reimers (*viz.* herb. Ind. Or. Hook. f. et Thoms. No. 1017).

Reimers probably used the term "minute denticulata" to indicate the difference with the other Himalayan species, *D. mussooriensis* Reim. = *D. declinata* (Mitt.) Zant., and *D. emodi* Reim. = *D. flaccida* (Card.) Broth. These two species have indeed got a stronger serrate leaf margin.

6. I have not seen the plant from Yuennan mentioned by Herzog (l. c. 1925) and because there has been a good deal of confusion about this species it is not certain that the plant is actually *D. wallichii* (Mitt.) Broth.

7. *Duthiella wallichii* (Mitt.) Broth. f. *robusta* Broth. nom. nud. mentioned by Brotherus in Symb. Sin. 4(1929)77 is actually *D. declinata* (Mitt.) Zant. (see there, note 2).

Plate IX. — Fig. 1: *Duthiella wallichii* (Mitt.) Broth., 1a habit (1/1), 1b leaves (12/1), 1c leaf cells (325/1), 1d leaf base (125/1), 1e peristome (125/1), 1f exostome tooth, inner face (125/1); Fig. 2: *Duthiella myuriiformis* Sak., 2a leaf (12/1), 2b leaf cells (325/1); Fig. 3: *Duthiella declinata* (Mitt.) Zant., 3a leaf (12/1), 3b leaf cells (150/1); Fig. 4: *Duthiella robusta* Nog., 4a leaf (10/1), 4b leaf cells (150/1); Fig. 5: *Duthiella formosana* Nog., 5a leaf (10/1), 5b leaf cells (150/1). (Fig. 1a, d–f after Brotherus, Nat. Pfl. ed. 2, 11(1925)122, Fig. 1b, c and Fig. 2, 3, 4 and 5 original).


1d
1e
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3b
3a
4a
1c
5a
2a
2b
5b

2. **Duthiella myuriiformis** Sak. — Plate IX, Fig. 2. Plate X, Map 1.
Sakurai, Bot. Mag. Tokyo 50(1936)518; Noguchi, J. Hattori Bot. Lab. (J. Hattori Shokub. Kenk.) 2(1947)63; Noguchi, J. Hattori Bot. Lab. 5 (1951)24; Sakurai, Musc. Jap. (1954)101.

Type specimen: Japan: Kiushiu, Prov. of Higo, Mt. Ryuhô, leg. Takahashi, 24-2-1935; holotype in herb. Sakurai, No. 7199.

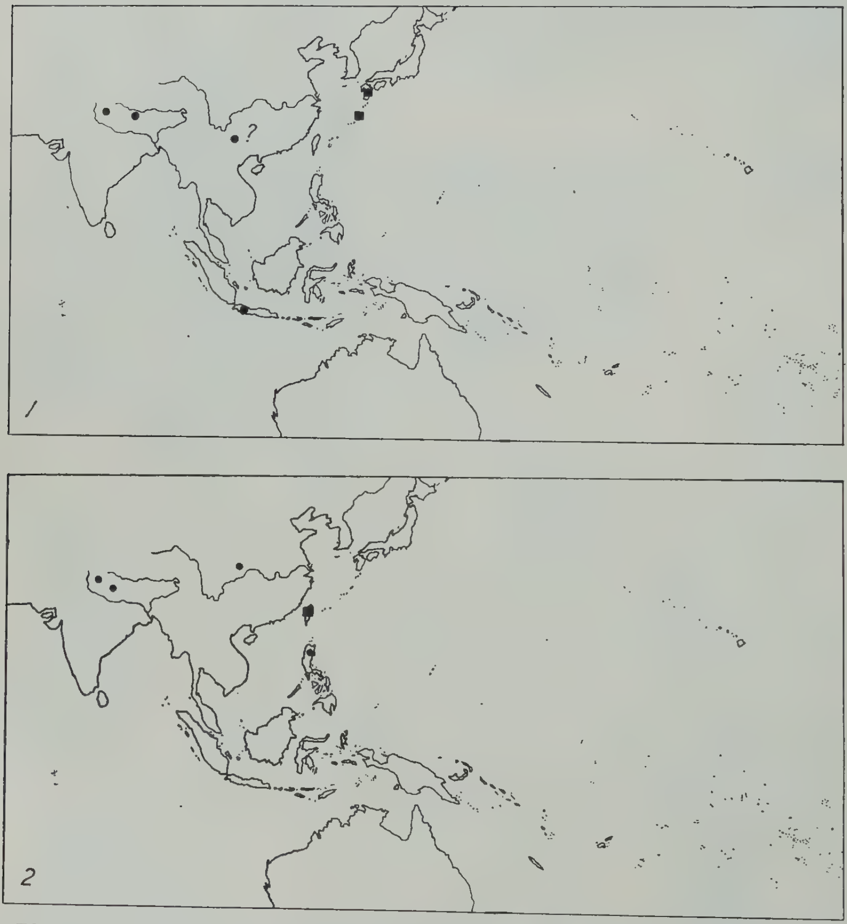

Plate X. — Map 1: Area of *Duthiella wallichii* (Mitt.) Broth. (●) and of *Duthiella myuriiformis* Sak. (■); Map 2: Area of *Duthiella declinata* (Mitt.) Zant. (●) and of *Duthiella robusta* Nog. (■).

Dioicous; *medium sized,* green or yellowish-green plants in *dull* mats. Secondary stems procumbent or somewhat ascending, irregularly or more or less pinnately branched, densely, not complanately foliate. Leaves spreading when dry, horizontally spreading when moist, up to 3 mm long, plane or faintly longitudinally plicate, often crisped near apex, from a broadly ovate, not auriculate base gradually or somewhat abruptly acuminate; leaf margin faintly to moderately serrate. Leaf rib single, ending below apex. Leaf cells *somewhat elongate*, 1.5—2.5 times as long as wide, *18—30 μ* long, towards base more elongate, on both sides *unipapillate* over lumen, *but in the upper part of the leaf mostly nearly smooth*; border cells not differentiated; alar cells quadrate to rectangular, smooth; cell walls rather thin, *not sinose.*

Seta about *1.5 cm* long, *in the upper part slightly mamillose.* Capsule horizontal, 2.5 mm long and 1 mm thick. Peristome not known.

JAPAN: Kiushiu: Prov. of Higo, Mt. Ryuhô, leg. Takahashi, 24-2-1935 (herb. Sakurai, No. 7199, isotype); Prov. of Higo, Kumamoto, Koonose, leg. Mayebara, 4-1948, ser. 3, No. 121 (GRO, L).

Distribution: Japan (Kiushiu and Riu-Kiu Islands).

Ecology: On calcareous rocks at about 100 m altitude.

Notes. 1. The present species is very closely allied to *D. wallichii* (Mitt.) Broth., but differs in the following characters:

a. leaf cells slightly more elongate and somewhat larger,
b. papillae in the upper part of the leaf less distinct or absent,
c. leaf base broader,
d. seta shorter, in the upper part slightly mamillose.

In how far these differences are stable ones will have to be investigated with the help of further material.

2. Although I saw an isotype I did not see the sporophyte.

3. **Duthiella declinata** (Mitt.) Zant. comb. nov. — Plate IX, Fig. 3. Plate X, Map 2.

Trachypus declinatus Mitt., J. Linn. Soc. Bot. Suppl. 1(1859)129; Paris, Ind. Bryol. (1898)1303; ibid. ed. 2, 5(1906)63; Fleischer, Hedwigia 61(1920)404. Excluded: van den Bosch and van der Sande Lacoste, Bryol. Jav. 2(1864)100.

Papillaria declinata (Mitt.) Jaeg., Ber. S. Gall. Naturw. Ges. 1875/76 (1877)273 = Ad. 2(1877)177.

Trachypodopsis declinata (Mitt.) Fleisch., Hedwigia 45(1906)65; Brotherus, Nat. Pfl. 1, 3(1906)831; Fleischer, Hedwigia 61(1920)404; Brotherus, Nat. Pfl. ed. 2, 11(1925)121; Bruehl, Rec. Bot. Surv. India 13, 1 (1931)68. Excluded: Fleischer, Musci Fl. Buitenzorg 3(1908)731.

Hypnum declinatum Wils. nom. nud.: Mitten, J. Linn. Soc. Bot. Suppl. 1(1859)129.

Duthiella complanata Broth. syn. nov.: Brotherus, Philipp. J. Sc. 5, 2, C, Bot. (1910)157; Brotherus, Nat. Pfl. ed. 2, 11(1925)123; van Steenis, Bull. Jard. Bot. Buitenzorg 3, 13(1934)164; Reimers, Hedwigia 76(1937) 289; Bartram, Philipp. J. Sc. 68(1939)197.

Duthiella mussooriensis Reim. syn. nov.: Reimers, Hedwigia 76(1937)289.

Duthiella wallichii (Mitt.) Broth. f. *robusta* Broth. nom. nud.: Brotherus, Symb. Sin. 4(1929)77; Reimers, Hedwigia 76(1937)289.

Type specimens: *Duthiella declinata* (Mitt.) Zant.: Himalaya, Simla, leg. Thomson, herb. Ind. Or. Hook. f. et Thoms. No. 1015; lectoholotype in K. — *Duthiella complanata* Broth.: Philippine Islands, Luzon, Subprov. of Benguet, Pauai, leg. MacGregor, 6-1909, Bur. Sc. No. 8706;

lectoholotype in H. — *Duthiella mussooriensis* Reim.: Himalaya, Mussoorie, Mt. Nag Tiba, leg. Bahadru, 23-12-1900, Levier, Bryoth. exot. 1(1907) No. 32; holotype in FI (under the name of D. wallichii (Mitt.) Broth.).

Dioicous ?; medium sized, yellowish-green plants, mostly in *slightly glossy* mats. Secondary stems procumbent or somewhat ascending, up to 6 cm long, irregularly pinnately or *slightly arborescently* branched, densely, either complanately foliate or not. Leaves erect spreading when dry, horizontally spreading when moist, up to 3 mm long, mostly faintly longitudinally plicate, undulate near apex, from an ovate, not auriculate base gradually rather long-acuminate; leaf margin *strongly serrate.* Leaf rib single, ending below apex. Leaf cells *elongate-hexagonal,* more elongate towards base, on both sides *unipapillate* over lumen (very rarely with two papillae), papillae occasionally more or less inconspicuous; border cells more elongate, larger, forming a *distinct border*; alar cells lax, quadrate, smooth; cell walls often more or less *sinuose,* mostly rather thin. Leaf cells often *greatly varying in width* and being of the same length.

Sporophyte as in the diagnosis of the genus. Seta about *2—3 cm* long. Basal membrane of the endostome *smooth.*

N.W. HIMALAYA: Jaunsi Deoban, leg. Duthie, 28-5-1899, c. seta (H, D. wallichii); Mussoorie, Mt. Nag Tiba, leg. Bahadru, 23-12-1900, c.fr. (FI, D. wallichii; holotype of D. mussooriensis); Simla, leg. Thomson, herb. Ind. Or. Hook. f. et Thoms. No. 1015, c.fr. (K, lectoholotype); Nubra, leg. Thomson, herb. Ind. Or. Hook. f. et Thoms. No. 1014 (K).

CHINA: Szechwan, Yenyen, near Kwapi castle, leg. Handel-Mazzetti, 30-5-1914, No. 2728 (H, D. wallichii var. robusta).

PHILIPPINE ISLANDS: Luzon: Subprov. of Benguet, Pauai, leg. MacGregor, 6-1909, Bur. Sc. No. 8706, c.fr. (H, D. complanata, holotype); Subprov. of Benguet, Mt. Santo Tomas, leg. Williams, 10-1904, No. 1722, c.fr. (H).

Distribution: N.W. Himalaya; Szechwan; Luzon.

Ecology: On trees and on rocks. Alt.: 1500—3100 m.

Notes. 1. The present species is easily to be distinguished from the previous one by the slightly glossy aspect, the mostly somewhat arborescent branching, the more appressed and longer acuminate leaves, the more elongate leaf cells (especially in the upper part of the leaf), the distinct leaf border and the strongly serrate leaf margin.

2. *D. declinata* has often been confused with *D. wallichii* (Mitt.) Broth. (see there, note 2).

D. wallichii (Mitt.) Broth. f. *robusta* Broth. nom. nud. is not to be distinguished from the type specimen of *D. declinata.* Reimers (l. c. 1937) states that *D. wallichii* f. *robusta* belongs to *D. mussooriensis* Reim. and because the latter is identical with *D. declinata* (Mitt.) Zant., this bears out my statement.

3. Reimers says in his original description of *D. mussooriensis* Reim. (l. c. 1937): "Diese Art steht der *Duthiella wallichii* nahe, unterscheidet sich von ihr aber durch die plötzlicher und schärfer zugespitzten Blätter, gestrecktes Zellnetz, kräftiger Randzähnelung und deutlichen Saum. Sie scheint habituell kräftiger zu sein als *D. wallichii*".

These differences are exactly those characters in which *D. declinata* differs from *D. wallichii* (with the exception of the more robust habit).

The type specimens of *D. mussooriensis* and *D. declinata* proved indeed to be wholly identical.

4. *D. declinata* hitherto used to belong to the genus *Trachypodopsis*, probably on account of its rather long-acuminate leaves and its somewhat elongate leaf cells. Because the sporophyte was said to be unknown (which was however based on an error, for the fruiting specimens of *D. declinata* were confused with *D. wallichii*) the exact position of the species, within the genus *Duthiella*, was not recognized.

But even when not in fruit this species can hardly be confused with one of the *Trachypodopsis* species on account of the absence of leaf auricles.

5. Jaeger, Ber. S. Gall. Naturw. Ges. 1875/76(1877)273, mentions the name *Pilotrichum declinatum* Doz. et Molk. nom. nud. as a synonym for *Papillaria declinata* (Mitt.) Jaeg., which name is said to be found in Bryol. Jav. 2(1864)100. This must however be an error for in Bryol. Jav. there does not occur any *Pilotrichum declinatum*.

4. **Duthiella robusta** Nog. — Plate IX, Fig. 4. Plate X, Map 2.

Noguchi, Trans. Nat. Hist. Soc. Formosa 24(1934)470; Noguchi, J. Hattori Bot. Lab. (= J. Hattori Shokub. Kenk.) 2(1947)63.

Type specimen: Formosa, Prov. of Sintiku, Mt. Rito, leg. Hirotu, 8-1925; holotype in herb. Noguchi, No. 609 (not seen).

Dioicous; *fairly robust*, green or yellowish-green plants in *dull* or *somewhat glossy* mats. Secondary stems procumbent, up to 7 cm long, densely irregularly branched, densely, either somewhat complanately foliate or not; branches up to 3 cm long. Leaves spreading to horizontally spreading when dry, horizontally spreading when moist, up to *4 mm* long, *not* longitudinally *plicate* or *crisped* near apex, from a broad, *not auriculate* base gradually or somewhat abruptly, rather long-acuminate; leaf margin rather *faintly* to *moderately serrate*. Leaf rib single, ending below apex. Leaf cells *elongate-hexagonal*, on both sides *unipapillate* over lumen, more elongate and smooth towards base, border cells *not differentiated*; alar cells few, quadrate to rectangular, smooth; cell walls *incrassate, pitted*.

Seta about *3 cm* long. Capsule not known.

FORMOSA: Prov. of Taihoku, Doba, leg. Noguchi, 23-8-1932 (herb. Noguchi, No. 6215).

Distribution: Formosa only.

Ecology: On rocks.

Notes. 1. The present species is remotely allied to *D. speciosissima* Card. and *D. formosana* on account of its fairly robust habit, but differs mainly by its incrassate, pitted cell walls, faint to moderate toothing and by the absence of leaf auricles.

From *D. declinata* (Mitt.) Zant. it differs mainly by its more robust habit, incrassate cell walls, faint or moderate toothing and by the absence of a leaf border and from *D. wallichii* (Mitt.) Broth. mainly by its more robust habit, incrassate cell walls and its more elongate leaf cells.

2. I have not seen the actual type but a specimen which, according to Noguchi, is identical with the type.

5. **Duthiella formosana** Nog. — Plate IX, Fig. 5. Plate XII, Map 1.

Noguchi, Trans. Nat. Hist. Soc. Formosa 24(1934)469; Noguchi, J. Hattori Bot. Lab. (= J. Hattori Shokub. Kenk.) 2(1947)62.

Type specimen: Formosa, Prov. of Takao, Mt. Daibu, leg. Kodaira, 1-1928; holotype in herb. Noguchi, No. 1758 (not seen).

Dioicous; *fairly robust,* green, yellowish-green or brownish-green plants in *dull-shining,* lax mats. Secondary stems procumbent, up to 7 cm long, irregularly pinnately branched, densely foliate. Leaves *appressed* to erect spreading when dry, erect spreading to horizontally spreading when moist, up to *4 mm* long, more or less longitudinally plicate, crisped near apex, from a broadly, mostly *faintly auriculate* base gradually or somewhat abruptly, rather long-acuminate; leaf margin *strongly serrate.* Leaf rib single, ending below apex. Leaf cells *elongate-hexagonal* to more or less *elongate,* on both sides *unipapillate* over lumen, more elongate and smooth towards base; border cells more elongate, forming a *distinct border,* mostly smooth; alar cells lax, *rather numerous,* quadrate, smooth; cell walls often *more or less sinuose,* rather *thin.* Leaf cells often greatly *varying in width* and being of the same length.

Sporophyte as in the diagnosis of the genus. Seta about *2.5 cm* long.

FORMOSA: Prov. of Tainan, Mt. Kodama, leg. Noguchi, 18-8-1932 (herb. Noguchi, No. 5847).

Distribution: Formosa only.

Ecology: On moist soil or decayed logs.

Notes. 1. This species is closely allied to *D. speciosissima* Card., but differs on account of the following characters:

a. leaves mostly appressed, often somewhat more abruptly acuminate,
b. leaf margin slightly stronger serrate,
c. cells towards the leaf margin forming a more distinct border, especially in the upper part of the leaf,
d. a larger number of alar cells,
e. a shorter seta.

The basal membrane of the endostome is, as shown in the figure given by Noguchi (l. c. 1934), papillose as in contrast with *D. speciosissima* Card.

The aerolation of the leaves bears close resemblance to that of *D. declinata* (Mitt.) Zant., but the general habit of the plants and the shape of the leaves are quite different.

2. I have not seen the actual type specimen, but a specimen without sporophyte which, according to Noguchi, is identical with the type.

6. **Duthiella speciosissima** Broth. ex Card. — Plate XI, Fig. 2. Plate XII, Map 1.

Duthiella speciosissima Broth. ex Card.: Cardot, Bull. Soc. Bot. Genève 2, 5(1913)317; Brotherus, Nat. Pfl. ed. 2, 11(1925)123; Reimers, Bot. Jahrb. 64(1931)544; Reimers, Hedwigia 76(1937)289; Noguchi, J. Hattori Bot. Lab. (= J. Hattori Shokub. Kenk.) 2(1947)63; Horikawa, Bull. Soc. Plant. Ecol. 2, 4(1953)144 (geographical distribution); Sakurai, Musc. Jap. (1954) 101; Chen, Fedd. Rep. 58(1955)29.

Matsumuraea japonica Okam., Bot. Mag. Tokyo 28(1914)106; Okamura,

J. Coll. Sc. Imp. Univ. Tokyo 36(1915)43; Brotherus, Nat. Pfl. ed. 2, 11(1925)123.

Pleuropus sakuraii Broth. nom. nud.: Cardot, Bull. Soc. Bot. Genève 2, 5(1913)317.

Type specimens: *Duthiella speciosissima* Card.: Japan, Honshiu, Prov. of Kai, Mt. Sasako, leg. Sakurai, 2-10-1910, ex herb. Brotherus, No. 472; holotype in PC. — *Matsumuraea japonica* Okam.: Japan, Honshiu, Prov. of Iga, Takikawa-mura, Naga-gun, leg. Sasaoka, 5-10-1913; lectotype in H.

Dioicous; *fairly robust*, green or yellowish-green plants in somewhat *glossy* mats. Secondary stems procumbent, up to 15 cm long, irregularly branched, densely foliate. Leaves erect spreading to spreading when dry, horizontally spreading when moist, up to *4 mm* long, more or less longitudinally plicate, crisped near apex, from a broadly ovate, *faintly auriculate* base more or less gradually, rather long-acuminate; leaf margin moderately to rather *strongly serrate*. Leaf rib single, ending below apex. Leaf cells *hexagonal to elongate*, up to 6 times as long as wide, mostly on both sides *unipapillate* over lumen, more elongate and smooth towards base; border cells mostly somewhat more elongate, smooth; alar cells present, *mostly few*, quadrate, smooth; cell walls rather thin.

Sporophyte as in the diagnosis of the genus. Seta about *5 cm* long. Basal membrane of the endostome almost *smooth*.

Japan: Honshiu: Prov. of Kai, Mt. Sasako, leg. Sakurai, 2-10-1910, ex herb. Brotherus, No. 472 (PC, holotype); Prov. of Sagami, O-Yama, leg. Sakurai, 28-8-1910 (PC); Prov. of Sagami, Mt. Tanzawa, leg. Sakuri, 28-8-1910. c. fr. (H); Prov. of Sagami, O-Yama, leg. Sakurai, 12-4-1940 (herb. Sakurai); Prov. of Musashi, Mt. Takao, leg. ?, 4-4-1911 (PC); Prov. of Iga, Takikawa-mura, Naga-gun, leg. Sasaoka, 5-10-1913 (H, Matsumuraea japonica, lectotype); Prov. of Tajima, Kinosaki, leg. Cono, 30-8-1906, c. seta (H); Prov. ?, Aichi, Kitashidara, Miwa, leg. Takaki, 9-1949, ser. 4, No. 176 (GRO, L); Prov. ?, Koino Kii, leg. Okamura, 31-7-1903 (H, Matsumuraea japonica).

Distribution: Japan (Honshiu, Kiushiu, Shikoku); China (Sikang, fid. Chen, l. c. 1955).

Ecology: On the ground. From low altitudes up to 1200 m.

Notes. 1. This species is easily to be distinguished from most other *Duthiella* species on account of its robust habit. It bears most resemblance to *D. formosana* Nog. (see there, note 1).

It bears also close resemblance to *Trachypodopsis serrulata* (P. Beauv.) Fleisch. var. *serrulata* when not in fruit (see there, note 4).

2. For the type specimen of *Matsumuraea japonica* Okam. (lectotype) Okamura mentioned as date of collecting 12-11-1913, this should however be 5-10-1913 as is indicated on the herbarium capsule.

7. **Duthiella flaccida** (Card.) Broth.

For literature and type specimens see below.

Dioicous; *medium sized*, green or yellowish-green plants in *dull* or rarely somewhat glossy mats. Secondary stems irregularly pinnately branched. Secondary stems and branches procumbent or somewhat ascending, mostly more or less complanately foliate. Leaves mostly spreading when dry, horizontally spreading when moist, plane or faintly longitudinally plicate and crisped near apex, from an ovate, *not auriculate* base more or less gradually acuminate; leaf margin *faintly*, but distinctly to moderately toothed or serrate; stem leaves sometimes somewhat shorter acuminate than the branch leaves. Leaf rib single, ending below apex. Leaf cells hexagonal or *elongate-hexagonal to linear*, 1.5—10 times as long as wide, 8—40 μ long, having the same length often *greatly varying in width*, on both sides *seriately papillate* over lumen (2—6 papillae), occasionally smooth or nearly so, towards base more elongate; border cells *not differentiated*; alar cells few, quadrate, smooth; cell walls rather thin or slightly incrassate, often more or less *sinuose*.

Sporophyte as in the diagnosis of the genus. Seta about *3 cm* long. Basal membrane of the endostome *strongly papillose*.

The present species is rather variable with 3 varieties which may be distinguished by the following key:

1. Papillae on the leaf cells indistinct or wanting; median leaf cells opaque, 12—25 μ long; stems and branches rigid . . . . . . 7b. var. **rigida** (Broth.) Zant.
1. Papillae on the leaf cells distinct; median leaf cells somewhat opaque or pellucid, 8—40 μ long; stems and branches mostly flaccid.
   2. Median leaf cells 8—25 μ long, mostly slightly opaque; cell walls more or less sinuose 7a. var. **flaccida**
   2. Median leaf cells 20—40 μ long, pellucid; cell walls not sinuose 7c. var. **media** (Nog.) Zant.

7a. **Duthiella flaccida** (Card.) Broth. var. **flaccida**. — Plate XI, Fig. 3a and 3b. Plate XII, Map 2.

Duthiella flaccida (Card.) Broth., Nat. Pfl. 1, 3(1908)1010; ibid. ed. 2, 11(1925)123; Bruehl, Rec. Bot. Surv. India, 13, 1(1931)68; Sakurai, Bot. Mag. Tokyo 46(1932)739; Reimers, Hedwigia 76(1937)289; Noguchi, J. Hattori Bot. Lab. (= J. Hattori Shokub. Kenk.) 2(1947)60; Noguchi and Hattori, J. Hattori Bot. Lab. 19(1958)122.

Trachypus flaccidus Card., Beih. Bot. Centralbl. 19, 2(1905)117.

Trachypodopsis flaccida (Card.) Fleisch., Hedwigia 45(1906)67.

Duthiella japonica Broth. ex Card.: Cardot, Bull. Soc. Bot. Genève 2, 3(1911)283; Brotherus, Oev. Finsk. Vet. Soc. Foerh. 62(1920)34; Brotherus, Nat. Pfl. ed. 2, 11(1925)123; Sakurai, Bot. Mag. Tokyo 46(1932)740; Reimers, Hedwigia 76(1937)289; Noguchi, J. Hattori Bot. Lab. (= J. Hattori Shokub. Kenk.) 2(1947)60; Sakurai, Musc. Jap. (1954)101.

Duthiella pellucens Thér. syn. nov.: Thériot, Bull. Géogr. Bot. 21(1911) 271; Brotherus, Nat. Pfl. ed. 2, 11(1925)123; Noguchi, J. Sc. Hiroshima Univ. B, 2, 3(1936)15; Reimers, Hedwigia 76(1937)289; Noguchi, J. Hattori Bot. Lab. (= J. Hattori Shokub. Kenk.) 2(1947)61; Noguchi and Hattori, J. Hattori Bot. Lab. 19(1958)122.

Duthiella perpapillata Broth. syn. nov.: Brotherus, Symb. Sin. 4(1929) 78; Reimers, Hedwigia 76(1937)289.

Duthiella lacustris Reim. et Sak., Bot. Jahrb. 64(1931)543; Noguchi, J. Hattori Bot. Lab. (= J. Hattori Shokub. Kenk.) 2(1947)60; Sakurai, Musc. Jap. (1954)101 (fid. Noguchi).

Duthiella emodi C. Muell. ex Reim. syn. nov.: Paris, Ind. Bryol. Suppl. (1900)133 (as nom. nud.); Reimers, Hedwigia 76(1937)288.

Duthiella brassii Bartr. syn. nov.: Bartram, Britt. 9, 1(1957)45.

Bryhnia olivacea Sak., Bot. Mag. Tokyo 46(1932)508; Sakurai, Musc. Jap. (1954)101 (fid. Sakurai).

Glossadelphus alaris (non Broth. et Yas.) Sak., Bot. Mag. Tokyo 52 (1938)135; Noguchi, J. Hattori Bot. Lab. (= J. Hattori Shokub. Kenk.) 2 (1947)60. (fid. Noguchi).

Duthiella flaccida (Card.) Broth. var. *gigantea* Nog. syn. nov.: Noguchi, J. Hattori Bot. Lab. (= J. Hattori Shokub. Kenk.) 2(1947)61.

Duthiella japonica Card. var. *pallida* Sak., Bot. Mag. Tokyo 51(1937) 796; Noguchi, J. Hattori Bot. Lab. (= J. Hattori Shokub. Kenk.) 2(1947)60; Sakurai, Musc. Jap. (1954)101.

Duthiella tortifolia Dix. nom. nud.: Noguchi, J. Hattori Bot. Lab. (= J. Hattori Shokub. Kenk.) 2(1947)60.

Type specimens: *Duthiella flaccida* (Card.) Broth.: Formosa, Prov. of Taihoku, Kushaku, leg. Faurie, 6-6-1903, No. 139; holotype in PC. — *Duthiella japonica* Card.: Japan, Shikoku, Prov. of Tosa, leg. Cono, 10-1905; holotype in PC. — *Duthiella pellucens* Thér.: China, Kwei-Chow, Pin-fa, leg. Cavalerie, 5-4-1904; holotype in PC. — *Duthiella perpapillata* Broth.: China, Yuennan, between Moengdse and Manhao, leg. Handel-Mazzetti, 7-3-1915, No. 6011; holotype in H. — *Duthiella lacustris* Reim. et Sak.: Japan, Honshiu, Prov. of Sagami, Hakone Mountains, Ashinoko-lake, leg. Sakurai, 3-1-1911, No. 327; type probably lost. — *Duthiella emodi* Reim.: N.W. Himalaya, Mussoorie, leg. Gollan, 26-11-1903; holotype in FI. — *Duthiella brassii* Bartr.: New Guinea, Mt. Dayman, leg. Brass, 6-7-1953, No. 23317a; holotype in herb. Bartram. — *Duthiella flaccida* (Card.) Broth. var. *gigantea* Nog.: Japan, Shikoku, Prov. of Tosa, Kochi, leg. Kamimura, 21-7-1935, No. 2117; holotype in herb. Noguchi. — *Duthiella japonica* Card. var. *pallida* Sak.: Japan, Kiushiu, Prov. of Higo, Nakaharu, leg. Mayebara, 13-12-1936; holotype in herb. Sakurai.

Plants *flaccid*, mostly complanately foliate, occasionally however not or hardly so. Leaves mostly rather faintly longitudinally *plicate*, *crisped* near apex when dry. Median leaf cells hexagonal to elongate-hexagonal, up to 7 times as long as wide, *8—25 μ* long, often *greatly varying in width* having the same length, mostly somewhat *opaque*; papillae on the leaf cells *distinct*; cell walls *sinuose*, rather thin to slightly incrassate.

JAPAN: Kiushiu: Prov. of Buzen, Shirakawa-m, leg. Ada, 4-10-1921, herb. Sasaoka No. 2138 (BM, D. tortifolia); Prov. of Higo, Nakaharu, leg. Mayebara, 13-12-1936 (herb. Sakurai No. 9408, D. japonica var. pallida, isotype); Prov. of Hyuga, Minaminaka, Kitago, leg. Noguchi and Hattori, 8-1946, ser. 1, No. 26 (GRO, L); Prov. of Higo, Kumamoto, Koonose, leg. Mayebara, 4-1948, ser. 3, No. 120 (GRO, L). — Shikoku: Prov. of Tosa, Kochi, leg. Kamimura, 21-7-1935 (herb. Noguchi, D. flaccida, var. gigantea, isotype); Prov. of Tosa, leg. Cono, 10-1905 (PC, D. japonica, holotype); Prov. of Tosa, ex coll. Cono, leg. ?, 11-10-1904 (H, D. wallichii). — Honshiu: Prov. of Ise, Dayingu, leg. Tsuchiya (= Tutija), 22-5-1927 (H, D. japonica).

FORMOSA: Prov. of Taihoku, Kushaku, leg. Faurie, 6-6-1903, No. 139 (PC, holotype).

PHILIPPINE ISLANDS: Luzon: Prov. of Laguna, Mt. Mahiling, leg. Deguilla and Apolinario, 6-5-1949, No. 3 and No. 5 (GRO); ibid. 6-6-1949, No. 12 (GRO). — Palawan: Mt. Mantalingajan, leg. Edano, 8-5-1947, No. 582, 583 and No. 584 (GRO); ibid. 5-5-1947, No. 623 (GRO).

AUSTRALIAN NEW GUINEA: Boianai, leg. Cruttwell, 31-10-1950, No. M 50 (GRO); Mt. Dayman, leg. Brass, 6-7-1953, No. 23317a (herb. Bartram, D. brassii, holotype).

CHINA: Kwei-Chow: Pin-fa, leg. Cavalerie, 5-4-1904 (PC, D. pellucens, holotype); Pin-fa, leg. Cavalerie, 25-1-1905, No. 1796, c.fr. (PC). — Yuennan, between Moengdse and Manhao, leg. Handel-Mazzetti, 7-3-1915, No. 6011 (H, D. perpapillata, holotype). INDIA: Mussoorie: Dehra Dun, Raspanna Valley below Mussoorie, leg. Duthie, 4-1-1892, No. 424 (FI); Arnigadh, leg. Gollan, 13-12-1895 (FI); leg. Duthie, 10-1879, c.fr. (FI); below old Botanic Garden, leg. Gollan, 26-11-1903 (FI, D. emodi, holotype). — Bhutan: Challoons, herb. late East India Comp. No. 498, herb. Griffith No. 53, leg. Bahadru (K, Hypnum wallichii). — Kumaon: Pheroka, herb. Strachey et Winterbottom (K, Hypnum wallichii).

Distribution: Japan; Philippine Islands; New Guinea; China (Yuennan, Szechwan, Kwei-Chow); India (Mussoorie, Bhutan, Kumaon).

Ecology: On the ground and on rocks. Alt.: up to 1800 m.

Notes. 1. A rather variable variety. The plant from Formosa (type specimen) and Yuennan (type of *D. perpapillata*) for instance deviate from most other plants (mostly identified as *D. japonica* or *D. emodi*) in having short, not complanately foliate stems and branches and strongly crisped leaves. Microscopically there is no difference and because there also occur intermediate forms (*e. g.* herb. Strachey et Winterbottom No. 78, K) it is not practical to separate these plants.

Noguchi (l. c. 1947) regards *D. japonica* Broth. as to be identical with *D. flaccida* (Card.) Broth. Sakurai however maintains it to be a separate species (l. c. 1954).

2. According to Brotherus (l. c. 1929) *D. perpapillata* Broth. is to be compared with *D. rigida* Broth., it bears however much greater similarity to *D. flaccida* (Card.) Broth. var. *flaccida*, for the leaves are strongly crisped when dry and the laef cells are distinctly papillate.

3. Although I have not seen the type specimen of *D. lacustris* Reim. et Sak. (probably lost) in my opinion it is almost certain that this species is conspecific with *D. flaccida* var. *flaccida* for the following reasons:

a. the characters mentioned in the original diagnosis all fall between the limits of *D. flaccida* var. *flaccida*.

b. the same holds good for the figure given with the diagnosis,

c. the authors based their new species on account of the shape of the leaves, which is in *D. flaccida* var. *flaccida* very variable and Reimers himself doubts whether the differences with *D. flaccida* are stable ones (l. c. 1931).

Noguchi also regards the plant to be conspecific with *D. flaccida* (Card.) Broth. (l. c. 1947). Sakurai however maintains it to be a separate species (l. c. 1954).

4. The type specimen of *D. brassii* Bartr. differs from that of *D. flaccida* var. *flaccida* in having more pellucid leaf cells with non-sinuose walls and in having its leaf cells all of the same width and it inclines therefore towards var. *media* (Nog.) Zant., which variety however is clearly distinguished on account of its having much more elongate leaf cells. Another specimen from New Guinea (Boianai, leg. Cruttwell, 31-10-1950, No. M 50 (GRO)) is intermediate between var. *flaccida* and the specimen identified as *D. brassii* Bartr.

5. I compared an isotype of *D. flaccida* (Card.) Broth. var. *gigantea* Nog. with the type specimen of *D. flaccida* from Formosa, but could not find great differences. Var. *gigantea* appeared to be only slightly more robust and to have somewhat less pellucid leaf cells, but is not at all to

be distinguished from most other specimens which belong to *D. flaccida.* The type specimen of *D. flaccida* (Card.) Broth. namely is not characteristic for this species. All other specimens I saw of this species were somewhat more robust than the type specimen. Brotherus called the plants from China consequently *D. wallichii* (Mitt.) Broth. f. *robusta* Broth. nom. nud. (l. c. 1929; he has confused *D. flaccida* with *D. wallichii,* see note 8) and Noguchi those from Japan *D. flaccida* var. *gigantea Nog.* (l. c. 1947).

6. *D. japonica* Card. var. *pallida* Sak. differs from *D. flaccida* var. *flaccida* only in its pale colour. In all probability it is only a skiophile form as Sakurai himself says (l. c. 1937), which opinion is fortified by the fact that the plant grew in a rocky hole. Also Noguchi (l. c. 1947) mentions var. *pallida* Sak. as a synonym for *D. flaccida* (Card.) Broth.

7. In his original description of *D. pellucens* Thér. (l. c. 1911) Thériot says that this species differs from *D. flaccida* (Card.) Broth. on account of its having more pellucid leaves, a slightly more robust habit, non-complanate, rigid, stronger serrate leaves etc., but when comparing the type specimens of the two species I could hardly find any differences.

8. In his description of *D. japonica* Card. (l. c. 1920), from the type specimen of Cardot, Brotherus compares this plant with *D. wallichii* (Mitt.) Broth. and according to this description it deviates principally in its somewhat less robust appearance. He does not however mention the two very conspicuous differences between the two species *viz.* that *D. japonica* has elongate, pluripapillate leaf cells and *D. wallichii* more or less isodiametric, unipapillate leaf cells.

Furthermore Brotherus states in the description mentioned above: "cellulis ellipticis, papillis paucis supra lumen instructis". This is right, but because he did not mention the above cited differences, it is clear in my opinion that by *D. wallichii* Brotherus meant a species very closely allied to *D. flaccida* with elongate, pluripapillate leaf cells, which is contradictory to the facts.

The same conclusion may be drawn from the following fact: in his original description of *D. rigida* Broth. (= *D. flaccida* (Card.) Broth. var. *rigida* (Broth.) Zant.; l. c. 1922 and 1929) Brotherus compares this species too with *D. wallichii,* but again he does not mention the above differences.

Not only Brotherus made this mistake but also Thériot, which may be concluded from the following fact: in his original description of *D. pellucens* Thér. (= *D. flaccida* (Card.) Broth. var. *flaccida;* l. c. 1911) Thériot states that this species differs from *D. wallichii* only on account of its having pellucid leaves. He too does not mention the two very conspicuous differences between *D. flaccida* and *D. wallichii.*

It is very unlikely that both Brotherus and Thériot should have overlooked these differences and in my opinion it is clear that these authors have confused *D. wallichii* (Mitt.) Broth. with another *Duthiella* species, which has elongate, pluripapillate leaf cells. *D. flaccida* (Card.) Broth. is the only species to be considered.

Which makes it even more likely that there must have been some confusion is the fact that the only specimen of *D. wallichii* I got from herb. Brotherus is actually *D. flaccida.*

In herb. Griffith and in herb. Strachey et Winterbottom (both in K) there are also plants under the name of *Hypnum wallichii* Schwaegr. which are in reality *D. flaccida* (*cf. D. wallichii,* note 3).

This confusion has also been noticed by Reimers when he writes: "Merkwürdigerweise ist die Typusart der Gattung *Duthiella, D. emodi* C. Muell. msc. offenbar niemals publiziert und fälschlicherweise mit *Hypnum wallichii* Hook. identifiziert worden, von dem sie aber ganz verschieden ist" (l. c. 1937).

Because *D. emodi* Reim. is conspecific with *D. flaccida* (Card.) Broth. this bears out my opinion.

The figure shown by Brotherus (l. c. 1908 and 1925) of *D. wallichii* however has got isodiametric, unipapillate leaf cells. Obviously Brotherus's conception of this species has not always been the same.

7b. **Duthiella flaccida** (Card.) Broth. var. **rigida** (Broth.) Zant. comb. nov. — Plate XI, Fig. 3c and 3d. Plate XII, Map 3.

Duthiella rigida Broth., Sitzungsber. Akad. Wiss. Wien 1, 131(1922) 218; Brotherus, Symb. Sin. 4(1929)78; Reimers, Hedwigia 76(1937)289.

Duthiella rivicola Sak., Bot. Mag. Tokyo 50(1936)264; Noguchi, J. Hattori Bot. Lab. (= J. Hattori Shokub. Kenk.) 2(1947)60.

Type specimens: *Duthiella rigida* Broth.: China, Yuennan, Hsinlung, leg. Handel-Mazzetti, 10-3-1914, No. 518; holotype in H. — *Duthiella rivicola* Sak.: Japan, Kiushiu, Prov. of Higo, Minamata, Ishizaka brooklet, leg. Kaneda, 26-5-1935; holotype in herb. Sakurai No. 5002.

Plants *rigid,* not or faintly complanately foliate. Leaves *plane,* not longitudinally plicate, not crisped near apex. Median leaf cells elongate-hexagonal, up to 7 times as long as wide, *all of about the same width, 12—25 μ* long, *opaque;* papillae on the leaf cells *absent or indistinct;* cell walls *not sinuose,* rather thin to slightly incrassate.

I have only seen the two above mentioned type specimens; neither of them were in fruit.

Distribution: Yuennan; Kiushiu.

Ecology: On sandstone rocks at 2000 m altitude (Yuennan) or in running water at low altitude (Kiushiu).

Notes. 1. The present variety is closely allied to var. *flaccida,* but differs mainly in the following characters:
a. stems and branches rigid,
b. papillae on the leaf cells absent or indistinct,
c. leaf cells more opaque,
d. all leaf cells of about the same width,
e. cell walls not sinuose.

In how far these differences are stable ones or have been caused by an aberrant habitat will have to be investigated with the help of further material.

2. *D. rivicola* Sak. differs from the plant from Yuennan in having longer stems with mostly appressed to erect spreading leaves. These differences may have been caused by the aberrant habitat in running water.

Noguchi regards *D. rivicola* Sak. to be conspecific with *D. flaccida* (l. c. 1947). Sakurai (l. c. 1954) however maintains it to be a separate species.

7c. **Duthiella flaccida** (Card.) Broth. var. **media** (Nog.) Zant. comb. nov. — Plate XI, Fig. 3e. Plate XII, Map 3.

Duthiella media Nog., J. Hattori Bot. Lab. (= J. Hattori Shokub. Kenk.) 2(1947)61.

Type specimen: Formosa, Prov. of Taihoku, Agyoku, leg. Suzuki, 11-2-1928, No. 469; holotype in herb. Noguchi.

Plants *flaccid*, more or less complanately foliate. Leaves mostly rather faintly longitudinally *plicate, crisped* near apex when dry. Median leaf cells elongate-hexagonal to linear, up to *10* times as long as wide, *all of about the same width, 20—40 μ* long, *pellucid*; papillae on the leaf cells *distinct;* cell walls *not sinuose,* rather thin.

FORMOSA: Prov. of Taihoku, Agyoku, leg. Suzuki, 11-2-1928 (herb. Noguchi No. 7267, isotype).

Distribution: Formosa only.

Ecology: No data.

Note. The present variety is closely allied to var. *flaccida,* but differs in the following characters:

a. leaf cells larger and more elongate, mostly more pellucid,
b. cell walls not sinuose,
c. all leaf cells of about the same width.

6. **Pseudotrachypus** P. Vard. et Thér.

Potier de la Varde and Thériot, Mem. Soc. Nat. Fel. Poey Cubana 14, 4(1940)357.

Medium sized, yellowish-green, slightly glossy plants. Stems *creeping,* up to 8 cm long, with tufts of blackish rhizoids, densely and *regularly* pinnately branched, rather densely foliate. Central strand absent. Branches short, up to 1 cm long, densely foliate. *Leaves dimorphous.* Stem leaves appressed to spreading when dry, erect spreading to horizontally spreading when moist, up to 2.5 mm long, longitudinally plicate, from a *deltoid* or *broadly ovate, auriculate* base long- and somewhat abruptly acuminate. Branch leaves erect spreading to spreading when dry, spreading to horizontally spreading when moist, up to 2 mm long, strongly longitudinally plicate, from an ovate, auriculate base *subulately* acuminate, with a short point. Leaf margin plane or slightly undulate, crenulate. Leaf rib single, *rather faint,* ending in or somewhat below midleaf. Leaf cells *linear,* up to *12* times as long as wide, mostly with a more or less distinct *papilla* over the lumen; marginal rows not differentiated; alar cells present, quadrate to rectangular, smooth; cell walls not incrassate, towards base somewhat thicker.

Gametoecia and sporophyte not known.

Type species of the genus is the only known species *Pseudotrachypus pinnatus* P. Vard. et Thér.

Relationships.

The classification of this genus is difficult because the sporophyte is not known.

It bears however resemblance to the genus *Trachypodopsis,* but differs

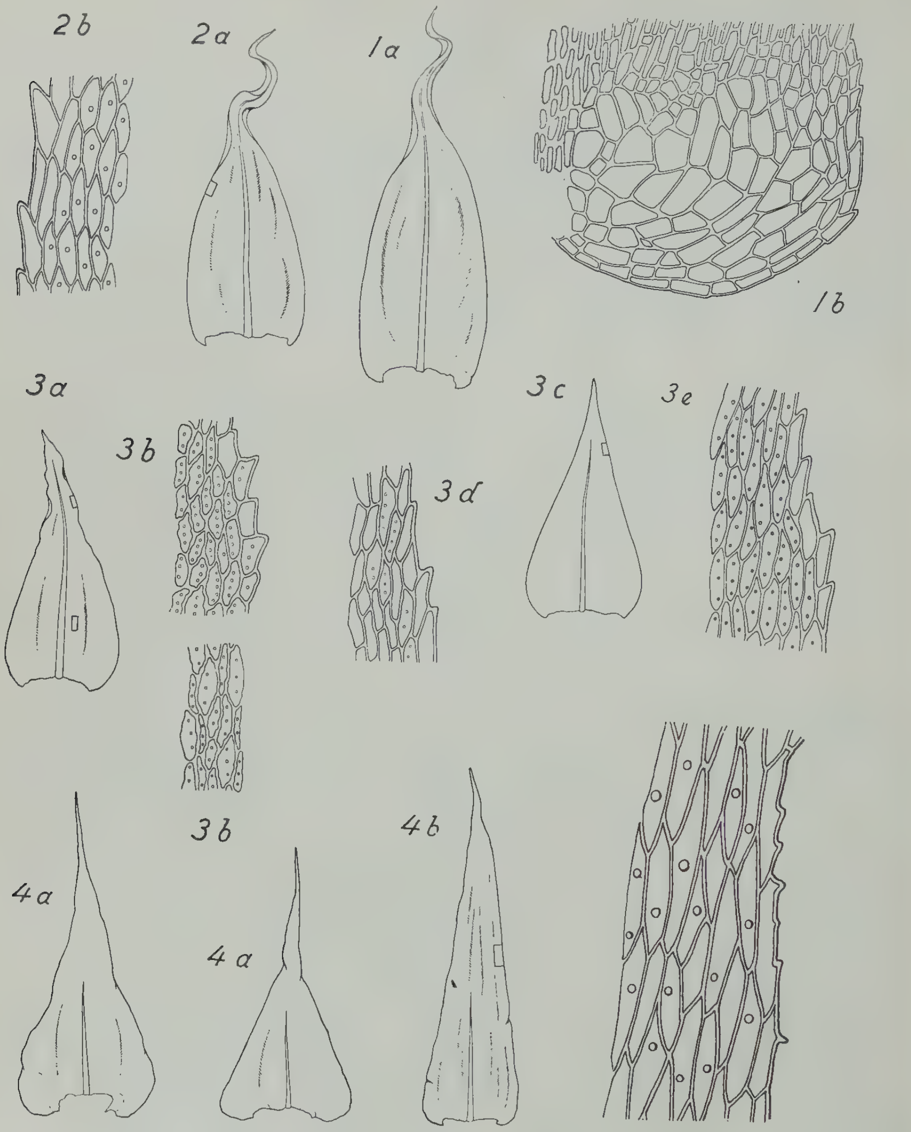

Plate XI. — Fig. 1: *Trachypodopsis laxoalaris* Broth., 1a leaf (15/1), 1b auricle (125/1); Fig. 2: *Duthiella speciosissima* Card., 2a leaf (10/1), 2b leaf cells (150/1); Fig. 3a, b: *Duthiella flaccida* (Card.) Broth. var. *flaccida*, 3a leaf (12/1), 3b leaf cells (150/1); Fig. 3c, d: var. *rigida* (Broth.) Zant., 3c leaf (12/1), 3d leaf cells (150/1); Fig. 3e: var. *media* (Nog.) Zant., leaf cells (150/1); Fig. 4: *Pseudotrachypus pinnatus* P. Vard. et Thér., 4a stem leaves (12/1), 4b branch leaf (12/1), 4c leaf cells (300/1). (Original).

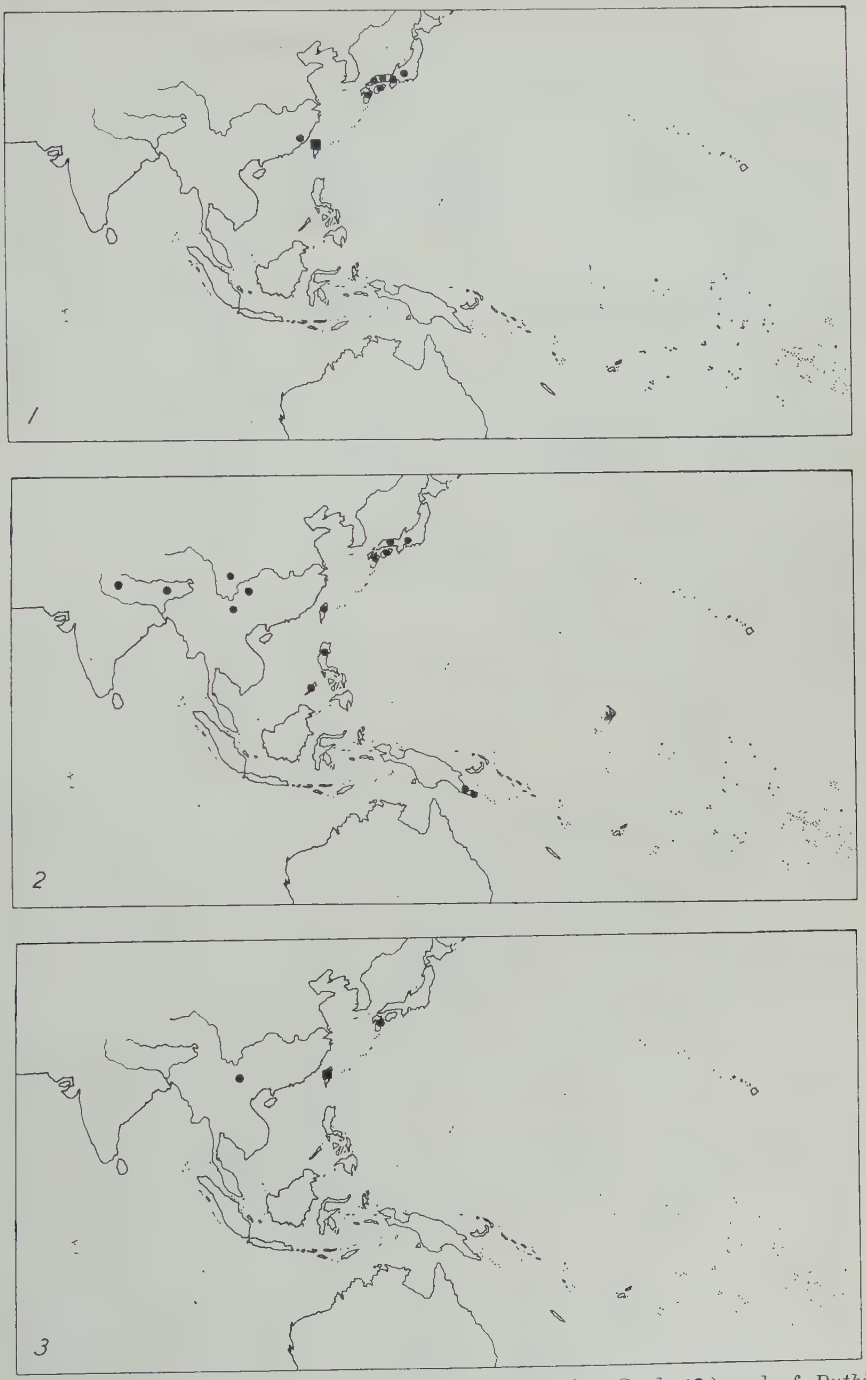

Plate XII. — Map 1: Area of *Duthiella speciosissima* Card. (●) and of *Duthiella formosana* Nog. (■); Map 2: Area of *Duthiella flaccida* (Card.) Broth. var. *flaccida*; Map 3: Area of *Duthiella flaccida* (Card.) Broth. var. *rigida* (Broth.) Zant. (●) and var. *media* (Nog.) Zant. (■).

from it by its creeping habit, its regular, pinnate branching, its strongly dimorphous leaves and its faint leaf rib.

Potier de la Varde and Thériot (l. c.) compare *Pseudotrachypus* with the genus *Trachypus* from which it differs however on account of its creeping habit, its regular, pinnate branching, the presence of auricles at the leaf base and because the papillae are situated over the cell lumen.

Unless the sporophyte indicates differently, the place of the genus *Pseudotrachypus* within the family of the *Trachypodaceae* is the most likely one.

1. **Pseudotrachypus pinnatus** P. Vard. et Thér. — Plate XI, Fig. 4.

For literature see above.

Type specimen: Cuba, Pinar del Rio, Rangel, leg. Acuna, No. 254; type in herb. Potier de la Varde.

Diagnosis as in the description of the genus.

Distribution: Cuba (found only once).

Ecology: No data extant.

SUMMARY

1. Trachypus.

1. *T. bicolor* Reinw. et Hornsch. is divided into 4 varieties:
a. var. *bicolor*,
b. var. *hispidus* (C. Muell.) Card.,
c. var. *viridulus* (Mitt.) Zant. comb. nov.,
d. var. *scindifolius* (Sak.) Nog.

2. *T. humilis* Lindb. is divided into 2 varieties:
a. var. *humilis*,
b. var. *tenerrimus* (Herz.) Zant. comb. nov.

3. *T. baviensis* Besch. has been transferred to the genus *Chrysocladium.*

4. *T. pendulus* Dix. has been transferred to the genus *Papillaria* as *P. semitorta* (C. Muell.) Jaeg.

5. The following species and varieties have been transferred to *T. bicolor* Reinw. et Hornsch. var. *bicolor:*
T. nietneri (C. Muell.) Par. syn. nov.
T. bicolor Reinw. et Hornsch. var. *sinensis* (C. Muell.) Broth.
T. appressus Fleisch. syn. nov.
T. cuspidatus Fleisch. syn. nov.
T. bicolor Reinw. et Hornsch. var. *pilifer* Fleisch. syn. nov.
T. bicolor Reinw. et Hornsch. var. *tenellus* Fleisch. syn. nov.
T. bicolor Reinw. et Hornsch. var. *simplicicaulis* Dix. syn. nov.
T. bicolor Reinw. et Hornsch. var. *floribundarioides* Nog. syn. nov.

6. The following species and varieties have been transferred to *T. bicolor* Reinw. et Hornsch. var. *hispidus* (C. Muell.) Card.:
T. bicolor Reinw. et Hornsch. var. *rigidus* (Broth. et Par.) Card.
T. paulensis (Broth.) Broth. syn. nov.
T. molliculus Broth. et Par. syn. nov.
T. rhacomitrioides Broth. syn. nov.
T. bicolor Reinw. et Hornsch. var. *brevifolius* Broth. syn. nov.

7. The following species, varieties and forms have been transferred to *T. bicolor* Reinw. et Hornsch. var. *viridulus* (Mitt.) Zant.:
T. molleri (C. Muell.) Broth. syn. nov.
T. laetus (Ren. et Card.) Broth. syn. nov.
T. subbicolor Card. syn. nov.
T. cuspidatus Fleisch. var. *brevifolia* Fleisch. syn. nov.
T. bicolor Reinw. et Hornsch. var. *hispidus* (C. Muell.) Card. f. *flagelliformis* Fleisch. syn. nov.
T. subbicolor Card. f. *robusta* Broth. syn. nov.

8. The following species, varieties and forms have been transferred to *T. humilis* Lindb. var. *humilis:*
T. massarti Ren. et Card. syn. nov.
T. novae-caledoniae Thér. syn. nov.
T. dimorphus Dix. et P. Vard. syn. nov.
T. massarti Ren. et Card. var. *brachyphyllus* Fleisch. syn. nov.
T. humilis Lindb. var. *brevifolius* Card. syn. nov.
T. humilis Lindb. var. *major* Broth. syn. nov.
T. humilis Lindb. f. *secundus* Nog. syn. nov.

9. The following species and varieties have been transferred to *T. humilis* Lindb. var. *tenerrimus* (Herz.)Zant.:
T. mauiensis Broth. syn. nov.
T. tenerrimus Herz. var. *flagelliferus* Herz. syn. nov.
T. humilis Lindb. var. *gracilis* Nog. syn. nov.

2. Trachypodopsis.

1. *T. serrulata* (P. Beauv.)Fleisch. is divided into 3 varieties:
a. var. *serrulata,*
b. var. *crispatula* (Hook.) Zant. comb. nov.,
c. var. *guilbertii* (P. Vard.) Zant. comb. nov.

2. The following species have been transferred to *T. serrulata* (P. Beauv.) Fleisch. var. *serrulata:*
T. nodicaulis (C. Muell.) Fleisch.
T. rutenbergii (C. Muell.) Fleisch.

3. The following species and subspecies have been transferred to *T. serrulata* (P. Beauv.) Fleisch. var. *crispatula* (Hook.) Zant.:
T. himantophylla (Ren. et Card.) Fleisch.
T. crispatula (Hook.) Fleisch. ssp. *macrodon* (Fleisch.) Reim. syn. nov.
T. otiophylla (Card.) Card. syn. nov.
T. densifolia Broth. syn. nov.
T. plicata Dix. syn. nov.
T. angustiretis Dix. syn. nov.
T. subulata Chen syn. nov.
T. crispatula (Hook.) Fleisch. ssp. *longifolia* Reim. syn. nov.

4. *T. ornans* (Reich.) Fleisch. has been transferred to *T. auriculata* (Mitt.) Fleisch.

5. *T. declinata* (Mitt.) Fleisch. has been transferred to the genus *Duthiella* as *D. declinata* (Mitt.) Zant.

6. *T. tereticaulis* Froehl. has been transferred to the genus *Diaphanodon* as *D. blandus* (Harv.) Ren. et Card. var. *blandus.*

3. Diaphanodon.

1. *D. blandus* (Harv.) Ren. et Card. is divided into 3 varieties:
a. var. *blandus,*
b. var. *recurvedentatus* Zant. var. nov.
c. var. *ceylonensis* Zant. var. nov.

2. The following species have been transferred to *D. blandus* (Harv.) Ren. et Card. var. *blandus:*
D. thuidioides Ren. et Card. syn. nov.
D. brotheri Ren. et Card.
D. javanicus Ren. et Card. syn. nov.
Trachypodopsis tereticaulis Froehl. syn. nov.

3. *D. ? gracillimus* Card. et Thér. has been transferred to the family of the *Thuidiaceae.*

4. *D. blandus* (Harv.) Ren. et Card. has become the type specimen of the genus instead of *D. thuidioides* Ren. et Card.

5. Duthiella.

1. *D. flaccida* (Card.) Broth. is divided into 3 varieties:
a. var. *flaccida,*
b. var. *rigida* (Broth.) Zant. comb. nov.,
c. var. *media* (Nog.) Zant. comb. nov.

2. *Trachypodopsis declinata* (Mitt.) Fleisch. has been incorporated within the genus *Duthiella* as *D. declinata* (Mitt.) Zant. comb. nov., to which species have been transferred the 2 following species:
D. complanata Broth. syn. nov.
D. mussooriensis Reim. syn. nov.

3. The following species and varieties have been transferred to *D. flaccida* (Card.) Broth. var. *flaccida:*
D. japonica Card.
D. japonica Card. var. *pallida* Sak.
D. pellucens Thér. syn. nov.
D. perpapillata Broth. syn. nov.
D. lacustris Reim. et Sak.
D. emodi Reim. syn. nov.
D. brassii Bartr. syn. nov.
D. flaccida (Card.) Broth. var. *gigantea* Nog. syn. nov.

4. *D. rivicola* Sak. has been transferred to *D. flaccida* (Card.) Broth. var. *rigida* (Broth.) Zant.

5. *D. guilbertii* Thér. et P. Vard. has been transferred to the genus *Trachypodopsis* as *T. serrulata* (P. Beauv.) Fleisch. var. *guilbertii* (Thér. et P. Vard.) Zant.

ADDITIONAL NOTES ON DILLENIACEAE 1—9

by

R. D. HOOGLAND*)

(Issued May 1st, 1959)

Since the publication of the Revision of the Genus *Dillenia* (Blumea 7, 1952, pp. 1—145) a number of additional collections have come to my notice. As is to be expected, the most interesting ones are from Eastern Malaysia, where the genus has developed a high degree of diversity and where the number of collections is still relatively small.

1. **Dillenia pteropoda** (Miq.) Hoogl. and **D. papyracea** Merr. (l. c. p. 28) (fig. 1)

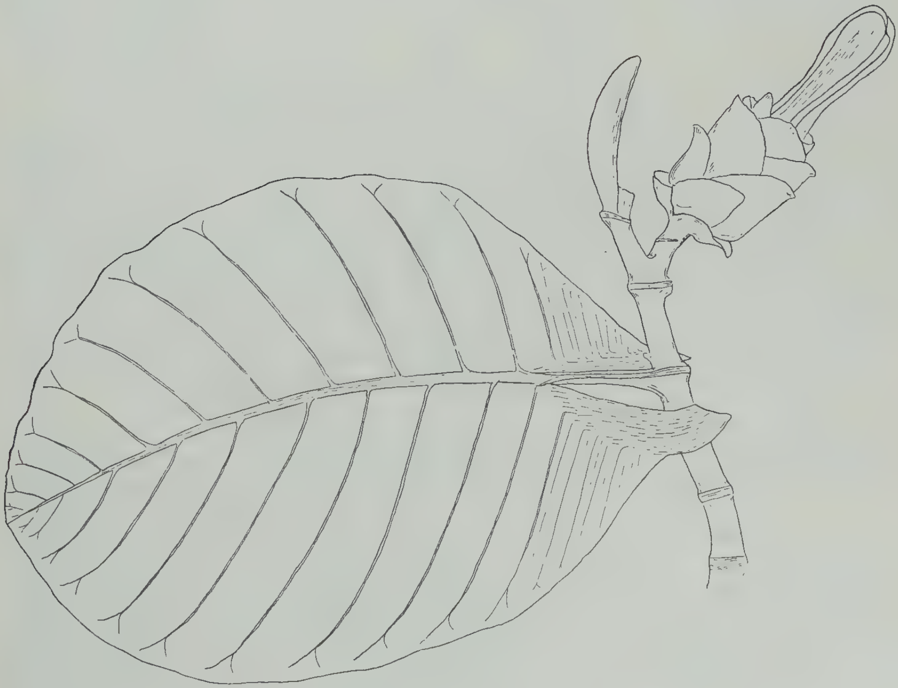

Fig. 1. *Dillenia pteropoda* (Miq.) Hoogl. After *Pleyte 260.* × $^3/_5$.

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*) C.S.I.R.O., Division of Land Research and Regional Survey, Canberra, Australia.

Dillenia pteropoda and *D. papyracea* were considered identical on account of the striking similarity of the leaves. *D. pteropoda* (*Wormia pteropoda* Miq.) was described from Halmaheira on leaves only and though the species was collected in the Moluccas on some occasions since, the flowers were still unknown when I revised the genus. A recent collection with flowers (*Pleyte 260,* Mumar near River Mumar, track Tasoa—Gn. Sembilan, 300 m alt., 25. XI. 1951; L) has come to my notice and shows that two distinct species are involved. It appears reasonable to retain Miquel's name for the species occurring in the Moluccas, though the two species cannot be distinguished with certainty from sterile specimens. The correct name for the Philippine species then is *Dillenia papyracea* Merr. (Philip. J. Sci. Bot. 9, 1915, p. 520), with *D. megalophylla* Merr. (Philip. J. Sci. 14, 1919, p. 421) and *Wormia papyracea* (Merr.) Gilg & Werderm. (in Engl. & Prantl, Nat. Pfl. fam. 2. Aufl. 21, 1925, p. 35) as synonyms. The description I gave of *D. pteropoda* (Miq.) Hoogl. (l. c. p. 28) fits this species.

As the two species are very similar in their vegetative parts, I only give here the description of one flower of Pleyte 260 (cf. fig. 1).

Flowers solitary, terminal, probably never expanding, sepals only slightly diverging in anthesis, petals falling without spreading. Pedicel ca 15—20 mm long, 5 mm thick, thickened to 8 mm at the apex, without bracteoles. *Sepals* 18, increasing in size towards the centre of the flower, the outermost one about orbicular, ca 20 × 20 mm, the innermost one broad-elliptic, ca 50 × 43 mm, all glabrous outside and inside. *Petals* 7, red, narrowly obovate, cucullate, ca 100 × 40 mm, rounded at apex, narrowed towards base (lower 30 mm about 8 mm broad). *Stamens* ca 220, slightly curved in bud, all of approximately the same length, 45 mm long; filament 22—30 mm long, 0.6—0.8 mm broad; anthers 0.8—1.2 mm broad. *Carpels* 10, arranged around a narrow conical receptacle, slightly spirally twisted, lanceolate-oblong, ca 17 × 6 mm, glabrous, each with ca 15—20 ovules; styles parallel, 23 mm long, cylindric, 1.3 mm thick at the base, channelled above.

Both species will be identified with my key (l. c. p. 18) as *D. pteropoda.* They can be separated as follows:

Sepals ∞. Flowers not fully opening, the petals coherent in anthesis, cucullate, ca 10 cm long, red . . . . **D. pteropoda**
Sepals 5. Flowers fully opening, the petals spreading, flat, ca 5 cm long, white **D. papyracea**

D. pteropoda is most distinctly characterised by the polymerous calyx (also found in *D. reifferscheidia* and *D. marsupialis* from the Philippines, which species have a different type of androecium) and possibly corolla (7 petals in the only flower examined). The latter character has not been found in any previously known species of *Dillenia* and it will be interesting to study more flowers as the one studied may have been incomplete. The corolla is not spreading in anthesis but falls off as a whole, a character previously not found West of New Guinea.

The species was recently also collected on one of the islands off the West coast of New Guinea: *Koster BW 1409,* Salawati (L).

2. **Dillenia ovalifolia** Hoogl. (l. c. p. 33)

Our knowledge of this species has been supplemented by three collections from Waigheo and Sorong, collected by Dr. P. van Royen (in L). *Van Royen 3409* from Mlasoen Hill E of Sorong is intermediate between var. *ovalifolia* and var. *sericea* Hoogl. in having the sericeous indumentum only on young branches, lower side of petiole and petiolar wings, basal part of midrib and lower nerves, and lower part of pedicel; the upper part of the pedicel and the sepals are practically glabrous. It does not appear possible to maintain the two varieties as sharply distinct taxa.

Van Royen 5240 and *5515* were both collected in Waigheo Island, NW of the Vogelkop peninsula. Herewith the occurrence of two species in Waigheo has been established, the other species being *D. alata* (DC.) Martelli described from Waigheo by Gaudichaud as *Wormia apetala*. The two species are quite similar in leaf-shape and particularly in the form and structure of the petiolar wing, but there is no doubt that Gaudichaud's specimen represents *D. alata* and not *D. ovalifolia*. *D. alata* was apparently not collected by Van Royen.

According to Van Royen, the petals are pink (*3409*), pinkish red (*5240*) or red (*5515*), whereas sofar only white petals were recorded. A similar variation is found in *D. reifferscheidia* where the rose-red form was distinguished as var. *rosea* Elm.

3. **Dillenia montana** Diels (l. c. p. 37)

This species, previously only known from two incomplete collections (*NGF 1026, 3380*) and the type (which I did not see) has recently been re-collected in some localities in the Central Highlands (Western Highlands Distr.) of New Guinea: *Hoogland & Pullen 6194* & *6265*, Komun-Pin Divide E of Korn, and *Robbins 516*, Kubor Ranges above Kuli. I studied six flowers and fruits of *H. & P. 6265*, preserved in alcohol, and found the following structure of the flower:

Sepals 5 (5 ×) or 7 (1 ×), in young flowers (buds) gradually diminishing in size from outer to inner; at time of flowering outer 3 about same size (33 mm high, 24 mm wide; = 45 mm long, 40 mm broad, measured on the outside along the curve), inner 2 smaller (29 by 21, resp. 39 by 41 mm); in fruit third sepal largest (38 by 32, resp. 54 by 51 mm), the outer (33 by 30, resp. 46 by 46 mm) and inner (35 by 27, resp. 50 by 55 mm) ones smaller. One nearly mature fruiting specimen had 7 sepals, of which no. 5 was distinctly the largest being 45 by 33 (resp. 62 by 58) mm.

There are 5 (2 ×) or 6 (2 ×) petals, ca 36 by 32 mm (measured along the curve), easily distinguished from the sepals by the much thinner (ca 2 mm thick) base (against 4—7 mm in the sepals). The petals appear to fall off at some stage of the flowering, though I could not find any petals under the trees as one can under similar species such as e. g. *D. papuana* and *D. schlechteri*.

The ca 110 stamens are ca 18 mm long, including 7 mm long filament, at the time of flowering; the anthers are ca 1.4 mm wide with the connective hardly exceeding the anthercells.

There are 9 (3 ×), 10 (2 ×) or 11 (1 ×) carpels, ca 14 mm long, 3 mm radially, and 2.5 mm wide at the time of flowering, glabrous, each with 2 rows of 6—7 ovules; the style is ca 11 mm long and recurved near the middle. In the fruiting stage the carpels are enlarged to 30 × 8 × 9 mm, with 1—3 seeds developed in each carpel, the styles are not only curved but also twisted. The seeds are ca 5 × 5 mm, enclosed by a 7 mm long fleshy aril with a split on one side and a slight opening at the apex.

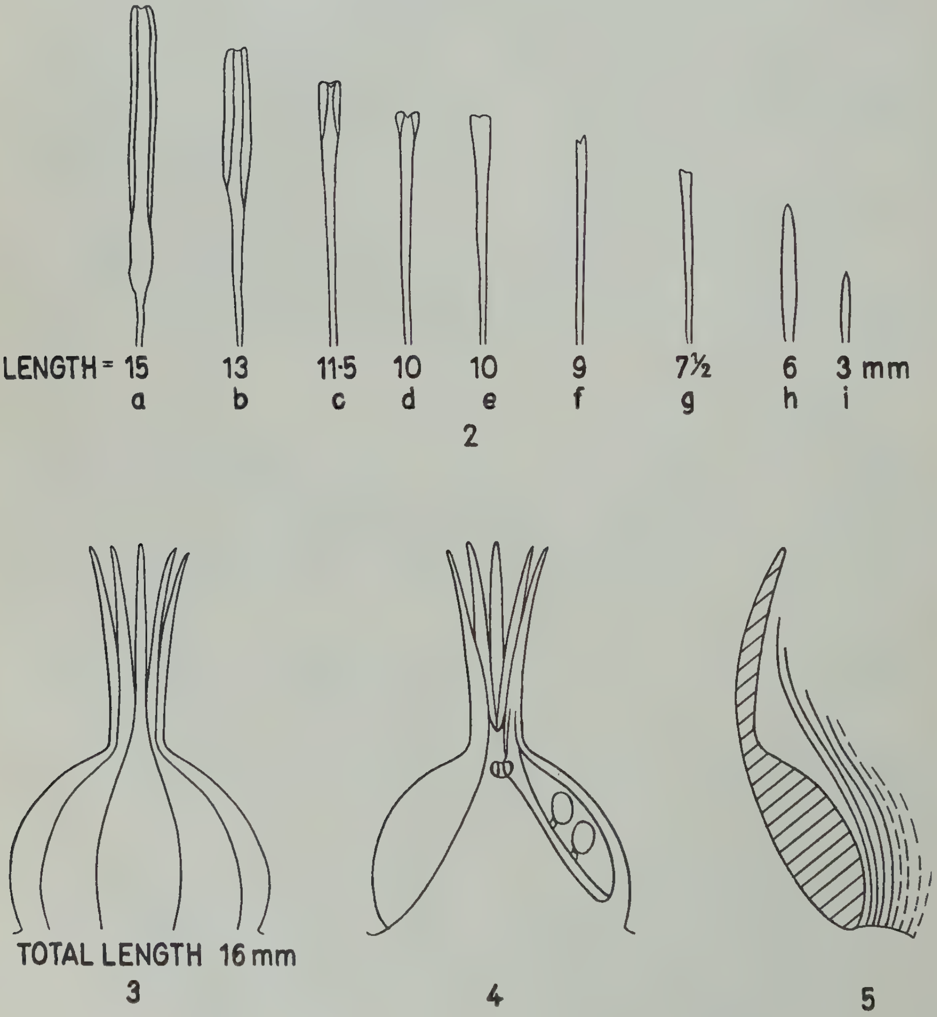


Fig. 2—5. *Dillenia nalagi* Hoogl. 2 a—d, stamens; e—i, staminodes; left to right = from centre of flower outward — 3. gynoecium, view from outside — 4. id., longitudinal medial section — 5. schematic representation of the structure and relation of gynoecium and androecium; shaded = gynoecium, full lines = stamens, broken lines = staminodes.

4. **Dillenia nalagi** Hoogl. *sp. nov.* (fig. 2—6)

Type: *Hoogland 3411,* near Devatutu, in regrowth; fairly common; alt. ca 15 m; fl. + fr. 22. VII. 1953 (holotype in CANB, isotypes in A, BM, BO, BRI, K, L, LAE, US). Paratypes: *Hoogland & Taylor 3438,* ca 1 km inland of Iwaia, Robinson Bay, dominant tree in juvenile rainforest on a ridge; very common; alt. ca 75 m; fl. + fr. 24. VII. 1953; *Hoogland & Womersley 3625,* along the Opi River near Patikiari, on riverbank and in rainforest on well-drained soil; common subcanopy tree; alt. ca 30 m; fl. + fr. 14. VIII. 1953.

Descriptio typi: *Rami* novelli dense sericeo-hirsuti; cicatrices amplexicaules. *Folia* ovata vel elliptico-oblonga, ca 24—80 × 15—30 cm, ca 18—32-nervata, apice rotundata vel retusa, basi obtusa, margine undulata; supra lucida, glabra, subtus breviter sericeo-hirsuta, glabrescentia. Petiolus ca 10—25 cm longus, alatus alis amplexicaulibus, caducis, lineari-oblongis, supra glabris, subtus sericeo-hirsutis. *Inflorescentiae* terminales, mox laterales et oppositifoliae, biflorae, usque ad 14 cm longae; flos terminalis bracteatus bractea spathulata, ca 35 × 17 mm, caduca, bracteolo uno lanceolato, ca 20 × 8 mm, caduco. *Pedicellus* ca 15—25 mm longus, dense sericeo-hirsutus. *Sepala* 5, ovata, 2 exteriora ca 45 × 35 mm, 2 interiora ca 35 × 28 mm, intus glabra, extus dense breviter sericeo-hirsuta, areis marginalibus in alabastro obtectis glabris, marginibus breviter ciliatis. *Petala* 5, obovata, cucullata, ca 35 × 18 mm, basi ca 7 mm lata, apice rotundata. *Staminodia* ca 365, exteriora ca 3 mm longa, apice acuta, interiora ca 10 mm longa, apice retusa vel bifurcata. *Stamina* ca 325, exteriora ca 10 mm longa, antheris ca 1 mm longis, interiora ca 15 mm longa, antheris usque ad 12 mm longis, apice bifurcata. *Carpella* 10—11, glabra, oblonga, ca 8 × 3½ mm, 6—8-ovulata, stylis subparallelibus ca 9 mm longis. *Fructus* dehiscens; sepala persistentia usque ad ca 65 × 40 mm; carpella ca 35 mm longa, 2 × 17 mm lata, 1—2-seminata. Semina ovata, applanata, ca 6 × 4½ × 3 mm, arillata arillo ca 7—8 mm longo.

Large evergreen *trees,* up to ca 30 m high, 60 cm diam., with short rather straight bole, often fluted, generally with fairly strong lower branches. Bark dull red-brown, papery-flaky; sapwood pale straw, heartwood reddish. *Branches* sympodial, younger ones ca 10 mm thick, rather densely sericeo-hirsute, glabrescent. Leafscars amplexicaul, for ca ¾ a rather broad single line, slightly bent downward on the leaf-opposed side, for ca ¼ a triangular scar with rounded, downward directed apex. *Leaves* ovate or obovate to elliptic-oblong, ca (18—)30—65(—80) × (10—)18—30 cm, with ca 15—23(—32) nerves on either side; rounded, often slightly retuse at apex, obtuse at base, sharply separated from petiolar wings; margin undulate to (in apical part of leaf) shallowly dentate, nerves curving upward near margin, finally parallel to margin or (in apical part of leaf) ending in apex of teeth, often 2 or 3 strong secondary nerves directed downward ca 1—2 cm from margin, curving upward towards margin, finally parallel to margin or (in upper part of leaf) ending in apex of smaller teeth; glabrous, rather glossy above, sparsely sericeo-hirsute on intervenium, densely so on midrib and nerves, glabrescent beneath. Petiole 10—18(—25) cm, glabrous above, densely sericeo-hirsute beneath, with amplexicaul wings; wings linear-lanceolate, up to ca 18 mm broad, obtuse at apex, glabrous above, densely sericeo-hirsute, subglabrescent beneath, wholly caducous. *Inflorescences* terminal, 2(—3)-flowered racemes, up to ca 15 cm long; axis usually curved backward, densely sericeo-hirsute, ca 7—5 mm thick, the upper flower with a bract; bract spathulate, up to ca 35 × 17 mm, caducous, glabrous above, densely sericeo-hirsute beneath. *Flowers* not expanding, sepals only slightly diverging in anthesis, petals falling off collectively without spreading. Pedicel ca 15—25 mm, ca 4—

6 mm thick, thickened at apex up to ca 8 mm, densely sericeo-hirsute, in upper flower with a single bracteole, in lower flower(s) without bracteole; bracteole linear-lanceolate, ca 20 × 8—30 × 4 mm. *Sepals* 5, ovate, yellow in flower, green in bud, pale orange-brown in fruit, the two outer ones ca 45 × 35 mm, the two inner ones ca 35 × 28 mm (all in fruit up to ca 65 × 40 mm), glabrous inside, densely sericeo-hirsute outside except for in bud covered margins which are glabrous for a width of ca 6 mm, short-ciliate at the margin. *Petals* 5, yellow, obovate, rather thick, cucullate when falling, ca 35—50 × 18—23 mm, rounded at apex, narrowed towards ca 7—10 mm broad base. *Androecium* consisting of staminodes on the outside and stamens on the inside, the length gradually increasing towards the centre; staminodes ca 365, ca 3—10 mm long, linear, the outer ones gradually narrowing into the acute apex, the inner ones broadening towards the retuse or shallowly bifurcate apex; stamens ca 325, ca 10—15 mm long, linear; filament in the outer ones ca 9 mm long, in the inner ones ca 3 mm; anthers ca 2 mm broad, retuse at apex; thecae linear, opening with apical pore. *Carpels* 10—11, arranged around broad conical receptacle, oblong,

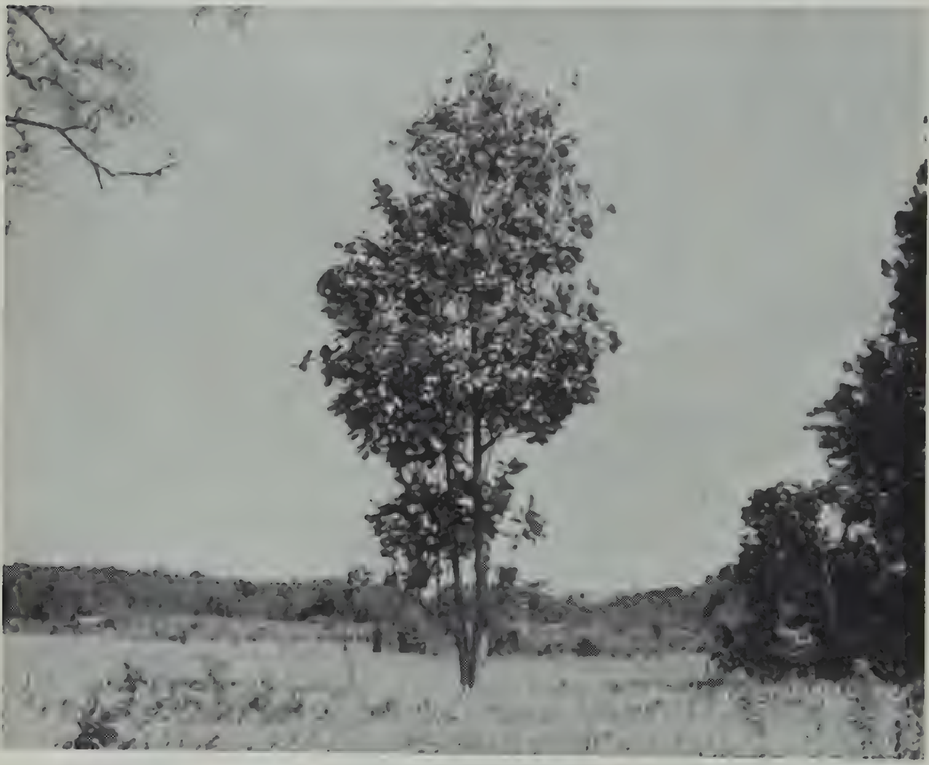


Fig. 6. A tree of *Dillenia nalagi* Hoogl. in grassland near Devatutu (near type locality).

ca 8 × 3½ mm, glabrous, each with ca 6—16 ovules; styles slightly spreading, ca 9 mm long, cylindric, ca 0.6 mm thick at base, channelled above. *Pseudocarps* dehiscent; carpels 30—35 mm long, 2 × 15—17 mm broad, each with 0—2 seeds. Seeds obovoid, ca 6 × 4½ × 3 mm, enclosed by rather thick fleshy white, ca 7—8 mm long, aril.

This new species was collected during the survey, carried out by the Land Research and Regional Survey Section (now Division) of C.S.I.R.O. in the Buna-Kokoda area, Northern District, Papua, in 1953. It is common to very common near the three localities cited. The only other lowland species of *Dillenia* found in this area, *D. quercifolia* (Lane-Poole) Hoogl. is more widespread, but less prominent in all its localities (*Hoogland & Womersley 3273* and *3286*, and *Hoogland 3842*). In the field the two species are easily distinguished, *D. nalagi* having a much paler bark (deep red-brown in *D. quercifolia*), larger leaves and flowers, and usually a different habit. *D. quercifolia* is a wellshaped tree (up to ca 40 m high) with long straight bole (up to ca 30 m long). The third species in the area, *D. schlechteri* Diels (*Hoogland 4011*) occurs only in the main mountain-range above ca 1200 m alt. and resembles *D. quercifolia* in its habit, barkcolour, leaves, and flowers.

The native name "nalagi", given to the species, was noted with the first two collections cited, given by local natives. For the third collection the name "dara" was noted, given by a native from Mumuni; in this village this is the common name for *D. quercifolia*, the only species of the genus represented in its vicinity.

The description of the floral parts was made after alcohol-material collected with the type.

The affinities of the new species are with *D. biflora* (A. Gray) Dur. & Jacks. from Fiji and the New Hebrides. It is distinguished from the latter by having its petiolar wings sharply separated from the blade, larger flowers, a larger number of carpels, and a much wider range in the length of the stamens and staminodes.

5. **Dillenia quercifolia** (Lane-Poole) Hoogl. **in the D'Entrecasteaux Islands**

The genus *Dillenia* was so far not recorded from the islands to the South-East of New Guinea. *D. quercifolia* (Lane-Poole) Hoogl., known from the Northern and Milne Bay Districts, was recently collected in Fergusson Island, a locality fitting well into its apparently limited distribution.

NEW GUINEA: D'Entrecasteaux Islands, Fergusson Island, between Niubuwo and Fagululu, *Brass 27307*, common and conspicuous in rain forest, 100 m alt., fl. 25. VI. 1956 (L).

Another species was found in the Louisiade Archipelago and appears to be new to science:

6. **Dillenia insularum** Hoogl. *sp. nov.* (fig. 7)

Type: *Brass 27730*, Sudest Isl., Joe Landing; common in relic primary rain forest of gullies; 100 m alt.; fr. 17. VIII. 1956 (holotype in L). Paratype: *Brass 27528*, Misima Isl., Mt. Sisa, north slopes; frequent in forest; 350 m alt.; fr. 27. VII. 1956 (L).

Descriptio typi: *Rami* novelli sparsim strigoso-villosi; cicatrices amplexicaules. *Folia* elliptico-oblonga, 10—25 × 5.5—15 cm, 9—12-nervata, apice rotundata, basi obtusa, margine subundulata. Petiolus 3—7 cm, alatus alis anguste lanceolatis, amplexicaulibus, caducis, apice minima parte persistenti. *Flores* solitarii, terminales. Alabastra subglobosa, ca 2 cm diam., pedicello 25—45 mm. Sepala 5, ovalia ad orbicularia, 25—30 × 20—30 mm, intus glabra, extus sericea, margine sparsim ciliata. Petala non visa. Staminodia ca 60, linearia, 2—5 mm longa, exteriora; stamina ca 260, subconformia, 6—10 mm longa, apice retusa, interiora. Carpella 7—9, elliptica, ca 10 × 6 mm, glabra, 6—8-ovulata, stylis subrecurvatis ca 7 mm longis. *Pseudocarpium* dehiscens, sepalis ad 40 × 22 mm, carpellis 20 × 16 mm, 1—2-seminatis, seminibus obovoideis 4.5 × 2.5 mm, arillo membranaceo 5.5 mm longo.

Evergreen *trees* up to ca 20 m high, 30 cm diam. Bark dark brown or mottled brownish-grey, somewhat scaly. Branches sympodial, younger ones 3—5 mm thick, sparsely short-hirsute, glabrescent, or glabrous. Leaf-scars amplexicaul, for about ½ a thin single line, for the other ½ triangular with rounded, downward directed apex and slightly emarginate upper margin, with ca 16 leaf-traces spread over scar except 1 mm broad marginal part. *Leaves* elliptic-oblong or elliptic, 10—25 × 5.5—15 cm, with 10—13 nerves on either side; rounded at apex, obtuse to rounded at base, sharply separated from petiolar wings; margin slightly undulate; sparsely appressed-villose on intervenium, sparsely villose on nerves and midrib, early glabrescent below; glabrous above. Petiole 3—7 cm, with amplexicaul wings; wings narrow-lanceolate to linear, 3—5 mm broad, glabrous above, sparsely villose, early glabrescent beneath, wholly caducous or (mostly) leaving a pair of small auricles at the base of the blade. *Flowers* solitary, terminal; just after flowering a globular bud, ca 2—2.5 cm diam. Pedicel 2.5—7.5 cm long, 2 mm thick, thickened to 4 mm at apex, glabrous or nearly so at base to densely shortly sericeous at apex; with a single linear-lanceolate bracteole 10—30 mm long, glabrous above, sparsely villose below. *Sepals* 5, 2 outermost ones suborbicular, ca 30 × 30 mm, 3 innermost ones elliptic, ca 25—30 × 20—23 mm, glabrous inside, densely shortly sericeous with in bud covered margins glabrous outside, very sparsely ciliate at margin. *Petals* unknown. *Stamens* and staminodes slightly curved in bud, the staminodes, ca 60, on the outside, from 2—5 mm long, the outer ones gradually narrowing into the acute apex, the inner ones broadening towards the obtuse to retuse apex; stamens ca 260, from 6—10 mm long, with 4—1 mm long filament and 1.0—1.5 mm broad anthers, retuse at apex; anthercells opening with apical pore continuing downward as a short slit. *Carpels* 7—9, arranged around a fairly broad conical receptacle, elliptical, ca 10 × 6 mm, glabrous, each with 6—8 ovules; styles spreading, filamentous, ca 7 mm long, 1.5 mm thick at base, 0.5 mm near apex, glabrous. *Pseudocarps* dehiscent, sepals enlarged to 3.2—4.0 × 1.8—2.2 mm; carpels ca 20 mm long, 2 × 8 mm broad, 1—2-seeded. Seeds obovoid, ca 4.5 × 2.5 mm, dark brown, enclosed by a 5.5 mm long, membranous aril.

This species, unfortunately available only with flowers past the flowering stage, is clearly related to *D. nalagi* Hoogl. It is at once distinguished by the smaller, solitary flowers and the much smaller number of staminodes.

NGF 2771 from Misima Island, a sterile collection previously referred by me to *D. auriculata* Martelli, probably represents the present species.

7. **Dillenia cyclopensis** Hoogl. *sp. nov.* (fig. 8)

Type: *Brouwer BW 2663,* Cyclops Mountains, common in secondary forest, 500 m alt.; fl. 9. XII. 1955 (holotype in L). Paratypes: *Schram BW 1983,* Cyclops Mountains, in primary forest, 220 m alt.; veg. 16. II. 1956 (L); *Schram BW 1897,* Cyclops Mountains, fairly common in secondary forest, 200 m alt.; fr. 16. II. 1956 (L); *Brouwer BW 2657,* Cyclops Mountains, fairly common in secondary forest, 500 m alt.; veg. 25. XI. 1955 (L);

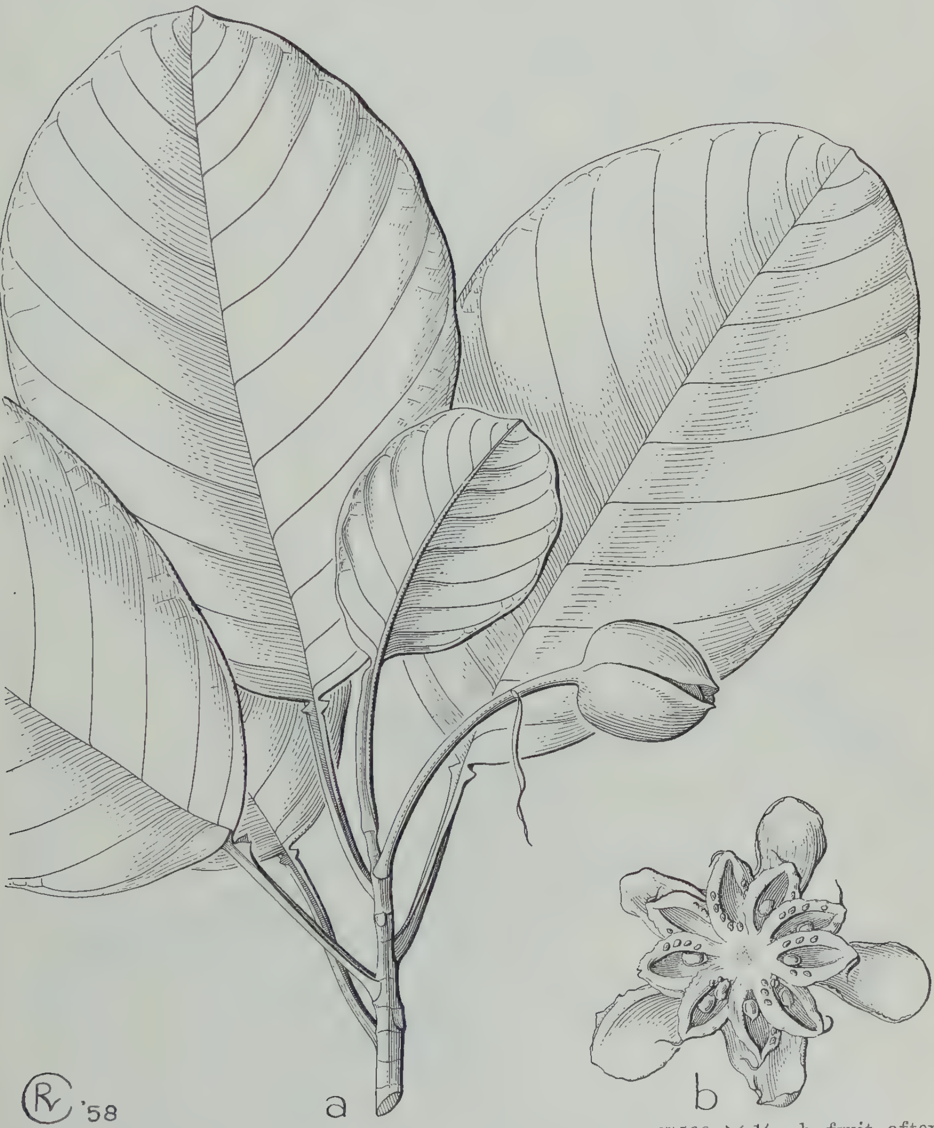


Fig. 7. *Dillenia insularum* Hoogl. a. habitus, after *Brass 27528,* × ½; b. fruit, after *Brass 27730,* × ½.

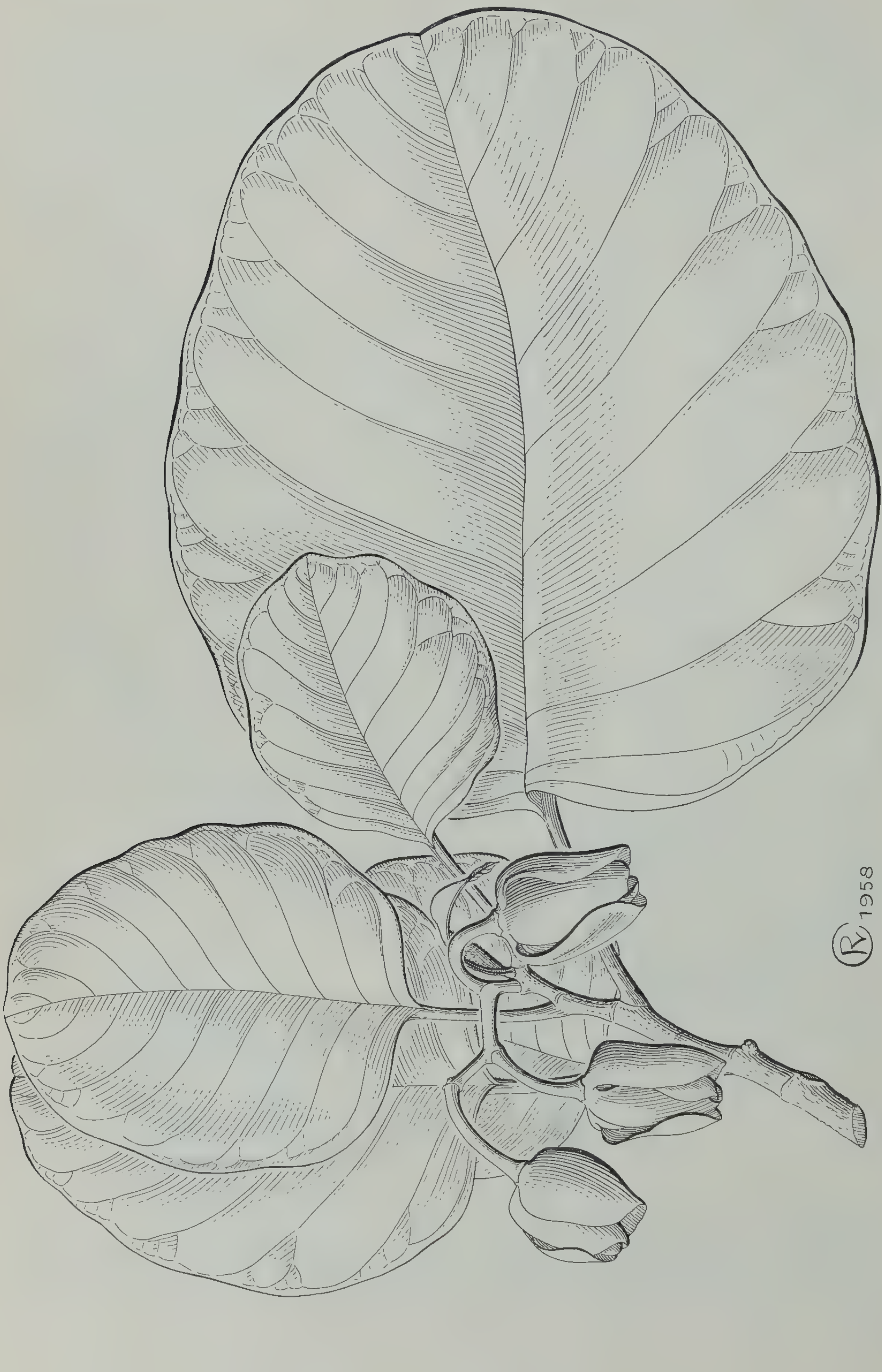


Fig. 8. *Dillenia cyclopensis* Hoogl. Habitus, after type specimen, × 1/3.

Kalkman BW 3626, Hollandia, fairly common in secondary (?) forest, 70 m alt.; fr. 28. XI. 1956 (L).

Descriptio typi: *Rami* novelli sparsim sericeo-hirsuti, glabrescentes, vetustiores dense lenticellati; cicatrices amplexicaules. *Folia* cordato-elliptica, 20—24 × 18—20 cm, 10—12-nervata, apice rotundata vel minime retusa, basi subcordata, margine undulata. Petiolus 5—6 cm, alatus alis lanceolatis, amplexicaulibus, caducis. *Inflorescentia* terminalis, brevis (pedunculus 1 cm, axis 3 cm longus), 3-flora. Alabastra elliptica, ca 4 cm longa, 2.5 cm lata, pedicello 27—35 mm. Sepala 5, 2 exteriora elliptico-oblonga, 55 × 35 mm, 3 interiora elliptica, 45 × 35 mm, intus glabra, extus sericea, margine sparsim ciliata. Petala 5, obovata, cucullata, ca 55 × 18 mm, basi ca 5 mm lata, apice rotundata. Staminodia perpauca (ca 10), subulata, 5—15 mm longa. Stamina ± 360, conformia, 18—20 mm longa, apice retusa, filamento 5—8 mm longo, antheris 1 mm latis. Carpella 11, glabra, lanceolata, ca 17 × 7 mm, ca 24-ovulata, stylis basi erectis, medio recurvatis, ca 20 mm longis.

Evergreen *trees*, up to ca 20 m high, 40 cm diam., with up to 10 m bole. Bark dark reddish brown, peeling off in thick to thin flakes. Branches sympodial, younger ones 3—8 mm thick, sparsely short-hirsute, glabrescent, older ones with numerous longitudinally stretched lenticels. Leaf-scars amplexicaul, for about $^2/_3$ a rather broad single line with on the leaf-opposed side a V-shaped downward bend, 2—3 mm deep, for the other $^1/_3$ triangular with rounded downward directed apex. *Leaves* cordate-elliptic or elliptic to ovate, 20—45 × 16—35 cm, with 10—15 nerves on either side; rounded to slightly retuse at apex, slightly cordiform or rounded to obtuse at base, sharply separated from the petiolar wings; margin undulate to slightly dentate, the nerves and 1—2 secondary nerves directed downward from the main nerves near the margin ending in the apex of the teeth or 2—3 mm from the undulate margin; glabrous on both sides. Petiole 5—10 cm, with amplexicaul wings; wings oblong, up to 25 mm broad, glabrous above, sparsely short-hirsute, glabrescent, or glabrous below; wholly caducous. *Inflorescences* terminal, 3-flowered racemes, up to 6 cm long, with tortuous axis; axis sparsely short-hirsute, ca 6—2 mm thick, without bracts. *Flowers* not expanding, sepals only slightly diverging in anthesis, petals falling off collectively without spreading. Pedicel ca 25—40 mm, ca 2—4 mm thick, thickened at apex up to ca 6 mm, short-hirsute, without bracteoles. *Sepals* 5, the 2 outer ones elliptic-oblong, ca 55 × 35 mm, the 3 inner ones elliptic, ca 45 × 35 mm (in fruit all ca 55 × 35 mm), glabrous inside, short-hirsute outside except for in bud covered margins which are glabrous for a width of ca 5 mm, sparsely short-ciliate at the margin. *Petals* 5, obovate, cucullate when falling, ca 55 × 18 mm, rounded at the apex, narrowed towards ca 5 mm broad base. *Stamens* ca 360, slightly curved, all of approximately the same length, 18—20 mm long; filament 5—8 mm long, 0.4—0.8 mm broad; anther ca 1 mm broad, retuse at apex; thecae linear, opening with apical pore; a few (ca 10) staminodes on the outside, subulate, 5—15 mm long. *Carpels* 8—11, arranged around a fairly narrow conical receptacle, lanceolate, ca 17 × 7 mm, glabrous, each with ca 24 ovules; styles erect, slightly spreading at the base, recurved at about the middle, ca 20 mm long, cylindric, 0.8 mm thick at base, channelled above. *Pseudocarps* dehiscent; carpels 28 × 16 mm; seeds not seen.

This new species is most closely related to *D. papuana* Martelli, *D. quercifolia* (Lane-Poole) Hoogl., and *D. schlechteri* Diels, having in common with these species the structure of the androecium, the non-spreading petals, and the tortuous axis of the inflorescence. From *D. papuana* it is distinguished by the short-hirsute indumentum on the outside of the sepals (which are glabrous in *D. papuana*) and the absence of the acumen on the anthers. From *D. schlechteri* and *D. quercifolia* it is immediately distinguished by the much larger flowers; the leaves are generally also larger, the number of nerves is intermediate between the two species.

8. Delima sarmentosa L.

Dr. R. C. Bakhuizen van den Brink pointed out to me that the binomial *Delima sarmentosa* was validly published by Linné as early as 1754 in Genera Plantarum ed. V on an unnumbered page with the heading "SPECIEBUS PLANTARUM. Adde." immediately following the Index. This publication of the binomial, valid through its reference to "*DELIMA. Fl. zeyl.* 205. *Amoen. acad.* I. p. 403" where descriptions of the singhalese species are found, is not entered in the Index Kewensis and was therefore overlooked in my study of the asiatic species of *Tetracera* for Flora Malesiana (cf. Reinwardtia 2, 1953, pp. 185—224).

I accepted Systema ed. X, 1759, p. 1076 as the valid publication of the binomial and here Linné gave hardly any description and no references, thus leaving the way open to accept the specimen in the Linnean Herbarium as the type. However, this specimen is not the singhalese species but the mainly Malaysian *Tetracera scandens* (L.) Merr.

In view of this I cannot maintain for the species concerned the name I used, i. e. *Tetracera asiatica* (Lour.) Hoogl. The correct names for this species and its subspecies are as follows:

Tetracera sarmentosa (L.) Vahl, Symb. Bot. 3, 1794, p. 70.

Basonym: *Delima sarmentosa* L., Gen. Pl. ed. V, 1754, pag. ult. (*sphalm. "Sparmentosa"*); *non* L., Syst. ed. X, 1759, p. 1076, *interpr.* Hoogl. 1951, 1953.
Synonyms: *Tetracera asiatica* (Lour.) Hoogl., Fl. Mal. I, 4, 1951, p. 143; Hoogl., Reinwardtia 2, 1953, p. 194; and as cited *ll. cc.*

Tetracera sarmentosa (L.) Vahl ssp. **sarmentosa**

Synonyms: *Tetracera asiatica* (Lour.) Hoogl. ssp. *zeylanica* Hoogl., Reinwardtia 2, 1953, p. 196; and as cited *l. c.*

Tetracera sarmentosa (L.) Vahl ssp. **asiatica** (Lour.) Hoogl. *comb. nov.*

Basonym: *Seguieria asiatica* Lour., Fl. Cochinch., 1790, p. 341.
Synonyms: *Tetracera asiatica* (Lour.) Hoogl. ssp. *asiatica*; Hoogl., Reinwardtia 2, 1953, p. 195; and as cited *l. c.*

Tetracera sarmentosa (L.) Vahl ssp. **andamanica** (Hoogl.) Hoogl. *comb. nov.*

Basonym: *Tetracera asiatica* (Lour.) Hoogl. ssp. *andamanica* Hoogl., Fl. Mal. I, 4, 1951, p. 144, *cum descr. angl.*; Hoogl., Reinwardtia 2, 1953, p. 195.
Synonyms: as cited *l. c.* (1953).

Tetracera sarmentosa (L.) Vahl ssp. **sumatrana** (Hoogl.) Hoogl. *comb. nov.*

Basonym: *Tetracera asiatica* (Lour.) Hoogl. ssp. *sumatrana* Hoogl., Fl. Mal. I, 4, 1951, p. 144; Hoogl., Reinwardtia 2, 1953, p. 195.
Synonyms: as cited *ll. cc.*

Delima sarmentosa L. and *Tetracera sarmentosa* (L.) Vahl are to be delated from the synonymy of *Tetracera scandens* (L.) Merr.; the further references are to be read "*Auct., non L.*".

9. Some additional records in Tetracera

Tetracera indica (Christm. & Panz.) Merr., until recently only known from Burma, Siam, Indo-China, the Malay Peninsula, Sumatra, and Java (Hoogl., Fl. Mal. I, 4, 1951, p. 146; Reinwardtia 2, 1953, p. 205), has been collected in Borneo by Kostermans (*no 10329*): Belajan River near Long Bleh, Central Kutei.

Tetracera akara (Burm. f.) Merr., until recently only known from S. India, Ceylon, Indochina, the Malay Peninsula, Sumatra, W. Java, Borneo, and Celebes (*l. c.* 1951, p. 146; 1953, p. 208) has been collected in the Philippines by Santos (*no 4231* and *4289*): Distr. of Lamitan, Basilan (SW of Mindanao).

CARIBBEAN FRESH AND BRACKISH WATER CHLOROPHYTA

by

C. VAN DEN HOEK

(Rijksherbarium, Leiden)

(Issued May 1st, 1959)

During his zoological collecting trips to the Antilles Dr. P. Wagenaar Hummelinck also gathered several samples of fresh and brackish water algae, which have been presented to the Rijksherbarium, Leiden. The present paper deals with the Chlorophyta of that collection, with the exception of *Enteromorpha*.

Wagenaar Hummelinck's localities 1936—1949 have been described in the "Studies on the Fauna of Curaçao", Vols. 1 (1940), 2 (1940) and 4 (1953). Sta. 76 A has been illustrated in Vol. 1, Plate Vb; Sta. 97 in Vol. 2, Plate IVa; Sta. 500, 382, 63 and 678 in Vol. 4, Plates Ib, IIa, IIb and Va, respectively. The 1955 localities will be described in a "Third List of Localities", to be published in a forthcoming volume of this series.

This study has been made possible by a grant from the "Natuurwetenschappelijke Studiekring voor Suriname en de Nederlandse Antillen" (Foundation for Scientific Research in Surinam and the Netherlands Antilles), to which organization I wish to express my sincere thanks.

I am grateful to Dr. Wagenaar Hummelinck who compiled the list of localities with its ecological data, and drew the map.

Frémy, in his paper on "Cyanophycées des Iles Bonaire, Curaçao et Aruba" (1941, p. 101—152) mentions the following freshwater Chlorophyceae:

Sta. 75 Curaçao, Tanki Mamaja, 6. X. 1936: *Coelastrum microporum* Näg., *Oocystis solitaria* Wittr. var. *elongata* Printz, *Gloeotaenium loitlesbergerianum* Hansg., *Cosmarium portianum* Archer and *Closterium leibleinii* Kütz. (p. 131).

Sta. 61 Klein Bonaire, Pos di Cas, 15. XI. 1936 (abt 400 mg Cl/1): *Cladophora crispata* (Roth) Kütz. em. Brand, *Rhizoclonium fontanum* Kütz. (p. 132).

Sta. 50 Bonaire, Tanki George, Deenterra, 25. III. 1937 (60 mg Cl/1): *Tetraspora lubrica* (Roth) Ag. (p. 133).

Localities

In the list of localities data are given about the following items respectively: station number, locality, date, dimensions of water body in m, movement, permanency, origin, soil in the neighbourhood, bottom, vegetation, salinity in mg Cl′/1, and often HCO_3' in mg/1, total hardness in German degrees, pH, and temperature in centigrades, from Wagenaar Hummelinck 1940 (p. 28), 1940a (p. 2—21), 1953 (p. 32—56), and according to a "Third List of Localities" to be published in a forthcoming volume of the "Studies on the Fauna of Curaçao and other Caribbean islands".

Margarita

13 Estanque Lato, 20. V. 1936. — 80 × 50 × ? 3; stagnant, dry for a short time; dug; schist debris; sand and mud, few algae with *Najas.* Cl 70, HCO_3 150, Germ.° 3, pH 6.8—7.1, 30—33°C. — *Chara zeylanica* f. *michauxii.*

17 Toma del Encañado, 13. VII. 1936. — 1½ × ¼; flowing, with pools; natural; metamorphic rocks; sand, leaf decay with sinter, some algae. Cl 270, HCO_3 760, Germ.° 42, pH 7.9—8.1, 28°C. — *Pithophora polymorpha.*

18 Laguna Honda, 16. V. 1936. — 20 × 30 × ? 1; stagnant, permanent?; natural; detritus with quartz; mud, many algae with *Najas.* Cl 150, HCO_3 160, Germ.° 5, pH 6.9—7.1, 26—32°C. — *Chara zeylanica.*

Bonaire

44 Pos Bronswinkel, 27. III. 1937. — 8 × 8 × 2; stagnant, overflowing, permanent; dug near spring; porphyrite; debris, mud, and plant decay, crowded with algae. Cl 530, HCO_3 420, Germ.° 14, pH 7.5—8.0, 28—30°C. — *Microspora stagnorum.*

48a Spring of Fontein, 30. III. 1937. — 1/5 × 1/10; flowing, permanent?; cemented gutter of spring; limestone; brickwork, sinter, very few algae. Cl 360, HCO_3 370, Germ.° 20, pH 8.2—8.4, 28°C. — *Rhizoclonium hieroglyphicum.*

52f Pos Ichi, 26. III. 1955. — Wet soil of dried pool; rather natural; limestone; sandy soil, some algae and remainders of *Chara.* — *Oedogonium howardii.*

53c Pos Baca, 16. IX. 1948. — 1½ × 1½ × ½; stagnant, permanent; rather artificial; limestone; rock and black mud, many algae. Cl 2580, HCO_3 165, Germ.° 54. — *Rhizoclonium hieroglyphicum.*

53d Pos Baca, 21. II. 1949. As before. Cl 550, HCO_3 365, Germ.° 17, pH ? 9.2. — *Rhizoclonium hieroglyphicum, Spirogyra minutipunctata.*

379a Pos Baca Grandi, 16. IX. 1948. — 8 × 7 × 1/10; stagnant, temporary; in sink hole; limestone; mud and rock, crowded with *Heleocharis* and *Chara.* Cl 1260, HCO_3 440, Germ.° 34. — *Chara zeylanica.*

379b Pos Baca Grandi, 27. XII. 1948. — 9 × 9 × 1/5; as before (fr. M. Arnoldo coll.). Cl 180, HCO_3 395, Germ.° 17. — *Chara zeylanica* f. *trichacantha.*

382a Sabana Punt Vierkant, 27. III. 1955. — Puddles drying up; natural; limestone; limestone, sinter and mud, much *Chara.* Cl 5400. — *Chara hornemanii.*

382c Sabana Punt Vierkant, 5. IV. 1955. — Puddles much dried up; as before. Cl 22900. — *Chara hornemanii.*

382d Sabana Punt Vierkant, 6. IV. 1955. — Puddles almost entirely dried up; as before. Cl 26200. — *Chara hornemanii.*

383 Pos Soedestsoed, 21. IX. 1948. — 1 × 1 × ½; stagnant, permanent?; rather natural; limestone; rock and debris, many algae. Cl 370, HCO_3 530, Germ.° 31. — *Oedogonium howardii, Pithophora oedogonia.*

628 Sabana Kralendijk, 16. IV. 1955. — Sheet of water 80 × 30 × 2/3; drying up; natural; limestone and detritus; mud and sinter, some *Chara* and bluegreen algae. Cl 11200. — *Chara hornemanii.*

Klein Bonaire

61b Pos di Cas, 7. IX. 1948. — 6 × 2 × 1; stagnant, permanent; sink hole; limestone; rock and black mud, algae. Cl 620, HCO_3 480, Germ.° 37. — *Rhizoclonium hieroglyphicum.*

63c Tanki Calbas, 7. IX. 1948. — 12 × 5 × ¼; stagnant, permanent?; in natural depression; limestone; mud and sinter, algae and small *Ruppia.* Cl 12160. — *Chara zeylanica* f. *armata, Chara zeylanica* f. *trichacantha.*

63d Tanki Calbas, 1. IX. 1949. — As before; considerable growth of *Ruppia.* Cl. 12410, pH 9.2. — *Chara zeylanica* f. *armata.*

Klein Curaçao

387 Pos N of lighthouse, 1. X. 1948. — 1½ × 1½ × ½; stagnant, permanent; artificial; limestone; rock with some debris, considerable growth of algae. — Cl 725, HCO_3 305, Germ.° 17. — *Palmodictyon varium, Oedogonium howardii.*

Curaçao

67 Bak di Hofje Groot St. Joris, 20. X. 1936. — 15 × 5 × 1; stagnant, temporary; cemented cistern near windmill, with overflow; diabase; brickwork with leaf decay, few algae. — Cl 790, HCO_3 550, Germ.° 50; pH 7.7, 29—32°C. — *Rhizoclonium hieroglyphicum.*

67a Bak di Hofje Groot St. Joris, 9. IV. 1949. — As before; considerable growth of algae. Cl 745, HCO_3 365, Germ.° 49. — *Rhizoclonium hieroglyphicum.*

70 Tanki Koenoekoe Hatoen, 15. X. 1936. — 10 × 5 × 1; stagnant, temporary?; dug; diabase and limestone; clayish mud, algae, with much *Chara* and few *Najas.* Cl 690, HCO_3 400, Germ.° 27, pH 8.4—8.6, 28—34°C. — *Chara zeylanica.*

72A Bak di Boca di Leeuw, Hato, 13. X. 1936. — 2 × 2 × 1; renewing, temporary?; cemented tank with overflow near spring; limestone and shale; brickwork and leaf decay, sinterish algae. Cl abt. 210, HCO_3 ca 280, Germ.° ca 16, pH 7.6—8.0, 29—31°C. — *Rhizoclonium hieroglyphicum.*

75 Tanki Mamaja, Hato, 6. X. 1936. — 40 × 20 × 2; stagnant, permanent; natural; limestone and detritus; mud, many algae with *Najas.* Cl 450, HCO_3 230, Germ.° 13, pH 8.6—8.8, 27—32°C. — *Sphaerocystis schroeteri, Coelastrum cambricum, Oocystis eremosphaeria, Gloeotaenium loitlesbergerianum.*

75a Tanki Mamaja, 10. XI. 1936. — As before. Cl 380, HCO_3 225, Germ.° 12, pH 8.4—8.6?, 27—30°C. — *Pithophora oedogonia, Chara zeylanica.*

76Aa Bron Wandongo, Hato, 11. X. 1936. — 1 × 1 × ¼; turbulent, near spring, permanent?; spring; limestone and shales; mud, *Chara* and *Najas.* Cl 240, HCO_3 300, Germ.° 18, pH 7.2—7.4, abt 28°C. — *Chara zeylanica* f. *guatemalensis.*

82 Pos Europa, Dokterstuin, 27. X. 1936. — 10 × 8 × ? 3; stagnant, temporary; dug; diabase; mud and plant decay, many algae. Cl 470, HCO_3 700, Germ.° 36, pH 8.6—9.2?, 28—32°C. — *Microspora quadrata, Pithophora polymorpha.*

88b Pos Sjimarrón, Savonet, 11. II. 1949. — Almost dry pool near spring; siliciferous cherts; rock debris, some sinter, few algae. Cl 760, HCO_3 335, Germ.° 31, pH 7.2? — *Pithophora aequalis.*

89 Tanki di Hofje Savonet, 29. X. 1936. — 12 × 10 × 1½; stagnant, temporary; dug; diabase detritus; mud and brickwork, crowded with algae. Cl 3200, HCO_3 780, Germ.° 160, 28—34°C. — *Oedogonium howardii, Spirogyra fluviatilis, Chara zeylanica.*

390 Pool at Museum, 25. IV. 1949. — 8 × 9 × ½; stagnant; basin of brickwork dd. Feb. 1949; masonry with some mud and plant decay, with *Nymphaea, Hydrocotyle, Eichhornia,* etc. Cl 725, HCO_3 180, Germ.° 49, pH 8.2. — *Cylindrocapsa conferta, Oedogonium howardii, Coelastrum scabrum, Chara zeylanica* f. *michauxii.*

391 Poole from Chinese gardens, Julianadorp, 4. I. 1950. — 2 × 1 × ½; stagnant, temporary?; cemented basins; diabase detritus; masonry, some detritus, algae. Cl estimated at 600—1000 (J. G. de Jong coll.). — *Rhizoclonium hieroglyphicum, Pithophora aequalis, Pithophora polymorpha.*

395 Bron di San Pedro, S spring in Hofje, 13. II. 1949. — ? ½ × 1/20; rather rapidly flowing, permanent; spring; chiefly limestone; rock debris and sand, some leaf decay, few algae. Cl 405, HCO_3 335, Germ.° 18. — *Rhizoclonium hieroglyphicum.*

396 Tanki di Tera Corá, Middle Curaçao, 20. VIII. 1948. — 4 × 3 × ¼; stagnant, containing water since 2—3 weeks; weathered shales; thick mud, some very young *Chara* and *Ruppia.* Cl 335, HCO_3 90, Germ.° 21, 28.5°C. — *Chara zeylanica.*

396a Tanki di Tera Corá, 1. XII. 1948. — 20 × 20 × ? ½; as before; much algae and *Najas.* Cl 160, HCO_3 135, Germ.° 8, pH 9.2?, 29.5°C. — *Sphaerocystis schroeteri, Oedogonium capilliforme, Oedogonium capitellatum, Oedogonium infimum.*

396b Tanki di Tera Corá, 29. I. 1949. — 15 × 15 × ½; as before; many algae and *Ruppia,* some *Chara.* Cl estimated at about 300. — *Oedogonium capitellatum, Oedogonium infimum, Spirogyra minutipunctata.*

397a Tanki Martha-Koosje, near Kleine Berg, 1. XII. 1948. — 35 × 25 × ? 1½; stagnant, temporary; for the greater part dug; chiefly weathered shales near limestone; soft mud, much algae with *Najas.* Cl 125, HCO_3 305, Germ.° 8, pH 9.0?, 27—29°C. — *Sphaerocystis schroeteri, Oedogonium capitellatum, Oedogonium howardii, Zygnemopsis americana, Spirogyra nitida.*

397b Tanki Martha-Koosje, 29. I. 1949. — 30 × 25 × ? 1½; as before, much *Najas* and *Chara,* both overgrown with algae. Cl 240, HCO_3 180, Germ.° 15. — *Chara zeylanica.*

397c Tanki Martha-Koosje, 11. II. 1949. — As before. Cl 280, HCO_3 120, Germ.° 16, pH 9.0. — *Oedogonium howardii, Oedogonium infimum, Spirogyra fuellebornii.*

397d Tanki Martha-Koosje, 15. IV. 1949. — 20 × 15 × ? 1; as before; dense growth of *Najas* and algae. Cl 510, HCO_3 150, Germ.° 11. — *Sphaerocystis schroeteri, Cylindrocapsa confertă, Coleochaete reticulata, Tetraedron regulare.*

Aruba

93b Pond of Fontein, 30. XII. 1948. — 20 × 15 × ½; stagnant, overflowing; permanent; rather artificial basin excavated near spring; chiefly limestone; rock, debris and leaf decay, thin coating of algae and floating algae masses. Cl 460, HCO_3 150, Germ.° 17. — *Rhizoclonium hieroglyphicum.*

93c Pond of Fontein, 12. VIII. 1955. — As before. Cl 510. — *Pithophora aequalis.*

97 Tanki Mon Plaisir, 15. XII. 1936. — 30 × 20 × 1; stagnant, temporary; dug and dammed; diorite-detritus; sandy mud and leaf decay, algae. Cl 60, HCO_3 140, Germ.° 4, pH 8.8—9.3, 27—32°C. — *Spirogyra distenta.*

99 Tanki Tibusji, 9. XII. 1936. — 15 × 5 × ¼; stagnant, temporary; dug; debris of schists and diorite; mud and debris, very few algae, few *Chara.* Cl 170, HCO_3 350, Germ.° 6, pH 8.5—9.0, 27—33°C. — *Chara zeylanica.*

104a Bron di Rooi Prins, 26. VIII. 1949. — Percolating water at spring, permanent?; natural; schists and diabase; debris, almost no algae, under pieces of rock. Cl 1345. — *Pithophora oedogonia.*

104Aa Bron di Rooi Prins, 26. VIII. 1949. — Some rapidly flowing water near spring, temporary; natural; schists and diabase; thin rock coating of algae. Cl 1345, HCO_3 670, Germ.° 40. — *Stigeoclonium lubricum.*

Paraguaná (Ven.)

105 Poza de la Compañía, Carirubana, 15. II. 1937. — 20 × 10 × 1½; stagnant, permanent?; dug in 1925; marls; marl debris, mud and oil residue, leaf decay; many algae with *Najas.* Cl 140, HCO_3 200, Germ.° 8, pH 9.0—9.4, 28—35°C. — *Spirogyra distenta, Spirogyra pseudospreiana.*

108 Estanque de Moruy, 18. II. 1937. — 100 × 30 × ? 3; stagnant, permanent?; natural?; limestone and hornblende rock; rock, sand and mud, algae with some *Najas.* Cl 50, HCO_3 200, Germ.° 6, pH 8.7—8.9, 28—31°C. — *Chara zeylanica* f. *michauxii.*

109 Estanque de Santa Fé, near Moruy, 18. II. 1937. — 30 × 30 × ? 1½; stagnant, permanent?; dug?; limestone and marl; clayish mud, algae with much *Chara, Najas* and *Ruppia.* Cl 120. HCO_3 250, Germ.° 5. — *Chara zeylanica.*

La Goajira (Col.)

114 Laguna del Pájaro, 21. I. 1937. — 300 × 200 × ? 1½; stagnant, permanent?; natural; detritus; sand and clayish mud, few algae with *Najas,* grasses. Cl 820, HCO_3 450, Germ.° 19. — *Oedogonium crispum* var. *uruguayense, Chara zeylanica.*

Surinam

119 Trench behind the Cultuurtuin, 2. V. 1936. — 10 × 1 × ¼; stagnant, permanent?; dug; detritus with shells; clayish mud with shells, crowded with algae and *Chara.* — Cl 30, 28—34°C. — *Oedogonium argenteum, Oedogonium crispum* var. *uruguayense, Oedogonium pusillum, Chara hydropitys.*

406 Swamp near Charlesburg, 2. VIII. 1948. ? 40 × 25 × 1; stagnant, permanent; partly dug; shell bearing sand; sand, some mud and plant decay, algae. Cl 18, HCO_3 30, Germ.° 3. — *Gloeotaenium loitlesbergerianum.*

Barbuda

667 Bull Hole, 9. VII. 1955. — 20 × 20 × 1/3; stagnant, temporary; natural depression in limestone area; muddy, with much *Najas* and *Chara,* few *Ruppia,* Cl 2200. — *Chara zeylanica.*

674 Low Pond near Village, 5. VII. 1955. — 20 × 15 × 1; stagnant, permanent; natural or partly dug in low limestone area near shore; muddy, crowded with *Chara.* Cl 2650, 32°C. — *Rhizoclonium hieroglyphicum, Chara zeylanica.*

Nevis

500 Nelson's Spring, 28. VI. 1949. — ? 200 × 15 × 1½; stagnant, permanent; natural; clayish soil, swamp deposits; clay, mud, decay; considerable growth of algae with *Najas.* Cl 88, HCO_3 485, Germ.° 17, pH 8.6. — *Spirogyra distenta, Spirogyra punctiformis.*

St. Eustatius

510 Samson Well, 10. VII. 1949. — 2 × 2 × ¾; stagnant, permanent?; artificial, 3½ m deep; vulcanic rock debris; debris, mud, plant decay, coating of small algae. Cl 2100, HCO_3 640, Germ.° 33, pH 7.9. — *Pithophora polymorpha* var. *polyspora.*

513 Cistern near Zeelandia, 8. VIII. 1949. — 3 × 2 × ½; stagnant, temporary?; old cistern; rock detritus, pasture; mud, plant decay, chiefly branches, some algae. Cl 35, HCO_3 210, Germ.° 10, pH 8.7. — *Pithophora polymorpha* var. *polyspora*.

St. Martin

528 Fresh-water pond of Point Blanche, 17. V. 1949. — ? 100 × 80 × ? ½; stagnant, temporary; natural; rock detritus with limestone; sandy mud, *Chara* with *Ruppia* and few algae. Cl 7800, pH ? 9.2. — *Chara hornemanii*.

529 Old Battery Cistern, 18. V. 1949. — 10 × 2 × ¼; stagnant, temporary; old cistern of brickwork, 2 m deep; chiefly limestone debris; rock with debris and plant decay, dense growth of algae. Cl 105, HCO_3 270, Germ.° 16, pH 8.1. — *Pithophora oedogonia*, *Tetraedron bifurcatum*.

529a Old Battery Cistern, 17. III. 1937. — As before, Cl estimated at about 200, filled by groundwater. — *Oedogonium howardii*.

530a Crab Hole Cistern, 2. VI. 1955. — 15 × 5 × ½; stagnant, permanent?; abandoned cistern of brickwork; rock debris, masonry, plant decay, much *Chara* with *Ruppia*. Cl 5200. — *Chara zeylanica* f. *trichacantha*.

532 Puddle in Rambeau Valley, 20. V. 1949. — 10 × ½ × 1/10; stagnant, temporary; drying rivulet; volcanic rock debris; mud and dirt, some small algae. Cl 380, HCO_3 1220, Germ.° 30, pH 7.2, 28°C. — *Rhizoclonium hieroglyphicum*.

538 Doctor's Well on rockland, 24. V. 1949. — 2½ × 2½ × 1; stagnant, permanent; dug, with stone wall, 2 m deep; weathered soil, pasture; mud with plant decay, debris, considerable growth of algae. Cl 355, HCO_3 1130, Germ.° 32, pH 8.0. — *Rhizoclonium hieroglyphicum*.

538a Doctor's Well, 29. VI. 1955. — As before. Cl 430. — *Rhizoclonium hieroglyphicum*, *Pithophora polymorpha*.

539 Puddle near Doctor's Well, 24. V. 1949. — 1/10 × 1/5 × 1/100; stagnant, temporary; weathered soil, pasture; mud trampled by cattle, few small algae. Cl 635, HCO_3 850, Germ.° 18, pH ? 8.0. — *Rhizoclonium hieroglyphicum*.

539a Puddle near Doctor's Well, 29. VI. 1955. — 15 × 3 × ½; as before. Cl 710. — *Rhizoclonium hieroglyphicum*, *Pithophora polymorpha*.

678 Fish nursery at Rolands Canal, 7. VI. 1955. — 10 × 1 × ½; stagnant, permanent; cemented trough filled by ground water; weathered soil of salt pond; brickwork, decay, dense growth of *Chara*. Cl 5850. — *Chara zeylanica* f. *trichacantha*.

679 Bloomendale Cistern, 7. VI. 1955. — 8 × 4 × 1; stagnant, permanent?; cemented cistern filled with ground water; weathered soil; brickwork, some decay; dense growth of *Chara*. Cl 1890. — *Chara hornemanii*.

Anguilla

544 Bedney's Spring, 18. VI. 1949. — 2 × 1½ × 1/3; stagnant, permanent?, excavated, 1 m deep; limestone and detritus; rock debris, soft mud, algae with *Chara*. Cl 1505, HCO_3 365, Germ.° 47, pH 8.2. — *Rhizoclonium hieroglyphicum*, *Chara zeylanica*.

Dog Island (near Anguilla)

546 Dog Island Well, 17. VI. 1949. — 2 × 2 × ? 1; stagnant, permanent?; dug; limestone; rock, some mud, almost no algae. Cl 1410, HCO_3 610, Germ.° 37, pH ? 8.0. — *Pithophora zelleri*.

New Providence (Bahamas)

548 Archbolds Pond near Nassau, 23. VIII. 1949. — ? 200 × 20 × ? 1½; stagnant, permanent; more or less artificial; garden soil on limestone; mud, decay, considerable growth of algae with *Chara* and other plants. Cl 17, HCO_3 210, Germ.° 12. — *Chara zeylanica* f. *trichacantha*.

Species and localities of the fresh and brackish water Chlorophyta treated in this paper

Species	Bahamas	Lesser Antilles													S. American mainland			Figs.
		Windward Group							Leeward Group									
	New Providence	St. Croix	Dog Island	Anguilla	St. Martin	St. Eustatius	Nevis	Barbuda	Margarita	Bonaire	Klein Bonaire	Klein Curaçao	Curaçao	Aruba	La Goajira	Paraguaná	Surinam	
Tetrasporales																		
Palmodictyon varium												×						1—2
Sphaerocystis schroeteri													×					4
Ulotrichales																		
Microspora quadrata													×					5
— stagnorum										×								6
Cylindrocapsa conferta													×					7
Stigeoclonium lubricum														×				8
Coleochaete reticulata													×					9—19
Oedogoniales																		
Oedogonium argenteum																	×	20
— capilliforme													×					21
— crispum var. uruguayense															×		×	22—24
— pusillum																	×	25
— capitellatum													×					26
— howardii					×					×		×	×					27—28
— infimum													×					29
Cladophorales																		
Rhizoclonium hieroglyphicum				×	×			×		×	×		×					30—31
Pithophora oedogonia					×					×			×	×				32—35
— aequalis													×	×				36—43
— polymorpha					×				×				×					44—48
— pol. var. polyspora.........						×												47
— zelleri			×															49—56
Chlorococcales																		
Coelastrum cambricum													×					57
— scabrum													×					58
Oocystis eremosphaeria													×					59—60
Gloeotaenium loitlesberg. ...													×				×	61—62
Tetraedron bifurcatum					×													63—64
— regulare													×					65—66
Zygnematales																		
Zygnemopsis americana							×						×					67
Spirogyra distenta													×	×		×		68—72
— fuellebornii																		73
— nitida													×					74—75
— fluviatilis							×						×					76—79
— punctiformis													×					80—81
— pseudospreiana																×		82—83
— minutipunctata										×			×					84—87
Charales																		
Chara hornemanii					×			×		×								
— hydropitys																	×	
— zeylanica	×			×	×			×	×	×	×		×	×	×	×		
— zeyl. f. guatemalensis ...		×											×					
— zeyl. f. armata											×							
— zeyl. f. trichacantha	×				×					×	×							
— zeyl. f. michauxii									×				×			×		

CHLOROPHYCEAE

TETRASPORALES

Palmellaceae

Palmodictyon Kützing

Groups of spherical cells inclosed in an irregularly branched or anastomosing gelatinous strand. Chloroplasts one or two within a cell, parietal, laminate; one or sometimes two pyrenoids within a cell.

Palmodictyon varium (Naegeli) Lemmermann

Lemmerman, Brunnthaler & Pascher 1915, p. 37; Smith 1950, p. 118; Prescott 1951, p. 85 — *Palmodactylon varium* Naegeli, *Palmodactylon simplex* Naegeli, *Palmodactylon subramosum* Naegeli in Naegeli 1849, p. 70—71.

Cells without distinct individual sheaths, 4—11 μ in diam., arranged in linear series or irregularly crowded in irregularly branched or anastomosing gelatinous strands 20—110 μ in diam. — Fig. 1, *1, 2.*

Distribution: Europe, U. S. A., Antilles (Klein Curaçao).

Locality: Klein Curaçao 387 (725 mg Cl/l).

According to Lemmermann (1915, p. 35) and Smith (1950, p. 118) pyrenoids do not occur in cells of *Palmodictyon.* In Kützing's type material of *P. viride* (in the Rijksherbarium at Leyden), however, pyrenoids are present, one in every cell. Fig. 1. *3.*

Sphaerocystis Chodat

A free-floating spherical colony, consisting of 4-many cells enclosed in a hyaline envelope; cells spherical, with one cup-shaped chromatophore containing one pyrenoid.

Sphaerocystis schroeteri Chodat

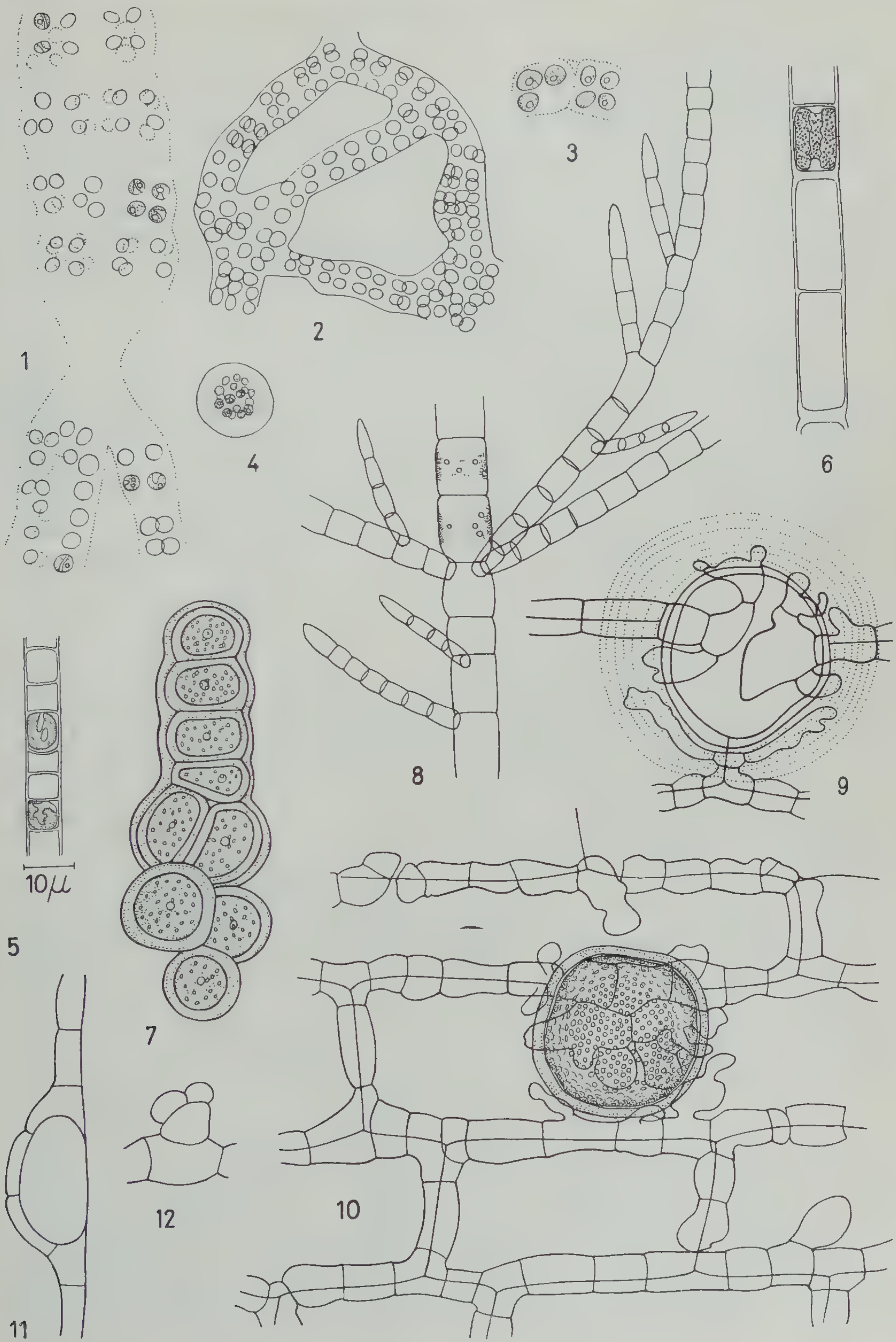
Chodat 1897, p. 119—120; Croasdale 1935, p. 44; Smith 1950, p. 166; Prescott 1951, p. 83; Tiffany & Britton 1952, p. 21; *Gloeococcus schroeteri* (Chodat) Lemmermann in Lemmermann, Brunnthaler & Pascher 1915, p. 31—32; Biswas 1949, p. 37.

Cells 2—7 μ in diam. in this material; according to other descriptions 6—22 μ. Colonies up to 75 μ in this material; according to other descriptions up to 500 μ. With characters of the genus. — Fig. 1. *4.*

Distribution: Europe, U. S. A., South Africa, India, Antilles (Curaçao).

Localities: Curaçao 75, 396a, 397a, 397d (125—510 mg Cl/l).

Fig. 1. *1, 2. Palmodictyon varium* from sta. 387, Klein Curaçao; *3. Palmodictyon viride,* type material of Kützing; *4. Sphaerocystis schroeteri* from sta. 397a, Curaçao; *5. Microspora quadrata* from sta. 82, Curaçao; *6. Microspora stagnorum* from sta. 44, Bonaire; *7. Cylindrocapsa conferta* from sta. 397d, Curaçao; *8. Stigeoclonium lubricum* from sta. 104Aa, Aruba; *9—12. Coleochaete reticulata* from sta. 397d, Curaçao, *9, 10.* ripe oospores, *11.* oospore, side view, *12. antheridia* (?).


10μ

ULOTRICHALES

Microsporaceae

Microspora Thuret

1. Microspora quadrata Hazen

Hazen 1902, p. 178; Heering 1914, p. 151; Croasdale 1935, p. 43; Prescott 1951, p. 108; Tiffany & Britton 1952, p. 29.

Vegetative cells 5—7 μ in diam., $1—1^1/_2$ × as long as broad, walls thin, sections not evident. Chromatophore covering entire cell-wall. Reproduction by spherical akinetes (not observed), 5—7 μ in diam. — Fig. 1. *5*.

Distribution: Europe, U. S. A., Antilles (Curaçao).

Locality: Curaçao 82 (470 mg Cl/l).

2. Microspora stagnorum (Kützing) Lagerheim

Heering 1914, p. 151; Prescott 1951, p. 108; Tiffany & Britton 1952, p. 29.

Vegetative cells 8—14 μ in diam., 1—3 × as long as broad, cylindric or slightly constricted at the cross-walls; walls thin, sections not evident; chromatophore a granular plate, not covering entire cell-wall. — Fig. 1. *6*.

Distribution: Europe, U. S. A., Antilles (Bonaire).

Locality: Bonaire 44 (530 mg Cl/l).

Cylindrocapsaceae

Cylindrocapsa Reinsch

Filaments short, unbranched, uniseriate, biseriate or forming irregular cell-heaps; vegetative cells provided with thick lamellose walls; chromatophore a massive, dense body containing one central pyrenoid; oogamous.

Cylindrocapsa conferta W. West

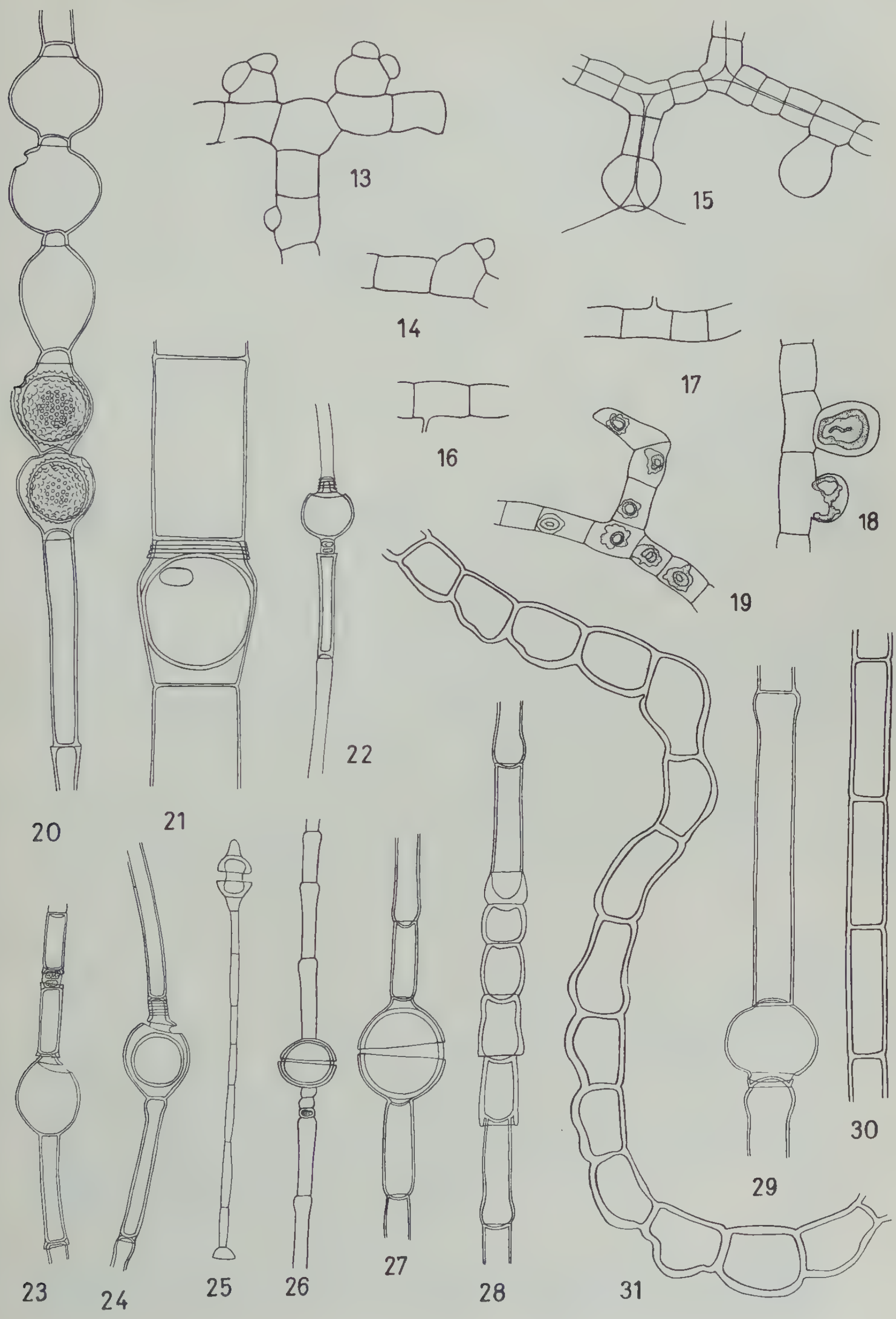
Heering 1914, p. 62—63; West & Fritsch 1927, p. 160; Printz 1927, p. 243, 244; Prescott 1951, p. 110.

Cells subrectangular or subrectangular-ovate, mostly shorter than broad, enclosed by a wide sheath of lamellate mucilage without envelope 20—30 μ broad, 13—32 μ long. Cells forming short filaments, or, by longitudinal and oblique divisions, irregular cell-heaps. Oogonia ± 40 μ in diam. (not observed). — Fig. 1. *7*.

Distribution: Europe (England), U. S. A. (Iowa, Wisconsin), Antilles (Curaçao).

Localities: Curaçao 390, 397d (510—725 mgCl/l).

Fig. 2. *13—19. Coleochaete reticulata* from sta. 397d, Curaçao, *13, 14.* antheridia (?), *15, 18.* young oogonia, *16, 17.* broken hairs, *19.* vegetative cells with chromatophores; *20. Oedogonium argenteum* from sta. 119, Surinam; *21. Oedogonium capilliforme* from sta. 396a, Curaçao; *22—24. Oedogonium crispum* var. *uruguayense* from sta. 119, Surinam ; *25. Oedogonium pusillum* from sta. 119, Surinam; *26. Oedogonium capitellatum* from sta. 397a, Curaçao; *27. Oedogonium howardii* from sta. 397d, Curaçao; *28. Oedogonium howardii* from sta. 387, akinetes, Klein Curaçao; *29. Oedogonium infinum* from sta. 396a, Curaçao; *30, 31. Rhizoclonium hieroglyphicum* from sta. 538, St. Martin.



Chaetophoraceae

Stigeoclonium Kützing

Stigeoclonium lubricum (Dillwyn) Kützing

Kützing 1845, p. 198; Collins 1905—1909, p. 298; Heering 1914, p. 81; Prescott 1951, p. 115; Tiffany & Britton 1952, p. 34.

Richly branched, with branches of 3, sometimes of 4 orders. Branches single, often whorled or nearly so. Branches ending in a blunt point or sometimes in a hyaline seta. Cells in the main filaments 14—19 μ in diam., $^2/_3$—2 × as long as broad. Cells of the branches of the last order 6—9 μ in diam., $^2/_3$—$2^1/_2$ × as long as broad. — Fig. 1. *8*.

Distribution: Europe, U. S. A., Antilles (Aruba).

Locality: Aruba 104Aa (1345 mg Cl/l).

Coleochaetaceae.

Coleochaete de Brébisson

Colechaete reticulata nov. spec.

Monoica; filamentis crescentibus in valleculis inter cellulas folii mortui exterioris partis Najadis, eo modo formantibus reticulum manifestum, raro consociatis in stratum pseudoparenchymatosum; cellulis visu rectangulis, 6—11 × 5—18 μ, transsectione compressis, interdum crine provisis hoc specimine semper defractis; cum uno chromatophoro parietali irregulari continente unum pyrenoidem magnum cuique cellulae; oosporis visu circulis vel irregulariter-circulis, diametro 18—30 μ, transsectione compressis, non totum opertis cortice composita ex cellulis irregularibus cum appendicibus inter se differentibus; oosporae membrana interna minute scrobiculata. — Fig. 1. *9—12*, 2. *13—19*.

Locality: Curaçao 397d (510 mg Cl/l) — *typus*.

It is impossible to state the presence of antheridia with certainty; most probably small papillose cells (3.5—7 × 6—8 μ) growing directly on the filaments or on one-celled side-branches are the antheridia.

OEDOGONIALES

Oedogoniaceae

Oedogonium Link

I. Dioecious, micrandrous — not present.
II. Monoecious or dioecious, macrandrous.
  A. Oogonia opening by a pore . . . . *Porifera*
  B. Oogonia opening by a lid . . . . *Operculata*

A. *Porifera.*
  a. Oogonia globose or obovoid-globose; pore superior; outer spore-wall scrobiculate; dioecious . . . . **1. O. argenteum**
  b. Oogonia only very slightly swollen; pore superior; spore-wall smooth; dioecious . . . . **2. O. capilliforme**

B. *Operculata.*
  a. Division of oogonium superior.
  Oogonia globose or obovoid-globose; spore-wall smooth; vegetative cells not capitellate, 7—14 × 30—70 μ; monoecious . . . . **3. O. crispum**
  b. Division of oogonium median.

1. Monoecious; oogonia subbiconic-ellipsoid; oospores ellipsoid, constricted in the middle; vegetative cells not capitellate, 3—6 × 10—21 μ **4. O. pusillum**
2. Monoecious; oogonia globose or depressed-globose; spore-wall smooth; vegetative cells capitellate, 6—10 × 18—50 μ . . . **5. O. capitellatum**
3. Dioecious; oogonia globose; spore-wall smooth; vegetative cells capitellate, diam. 7—14 μ . . . . **6. O. howardii**

c. Division of oogonium inferior.
Dioecious; oogonia globose or depressed-globose; division at the lowest extremity of oogonium; vegetative cells capitellate, 60—140 × 12—20 μ **7. O. infimum**

1. **Oedogonium argenteum** Hirn

Hirn 1900, p. 289; Tiffany 1930, p. 96—97; Gemeinhardt 1939, p. 164; Prescott 1951, p. 166.

Dioecious, macrandrous; oogonia 1—5 in a row, obovoid-globose to globose to somewhat depressed-globose, opening by a superior pore, 30—50 μ broad, 35—60 μ long; oospores ovoid-globose, entirely filling or not entirely filling the oogonium; outer layer of sporewall scrobiculate, inner layer smooth, 33—43 μ broad, 33—43 μ long; vegetative cells 4—18 μ in diam., 4—8 × as long as broad. — Fig. 2 *20*.

Distribution: Brazil (Matto Grosso), U. S. A. (Michigan), Surinam.

Locality: Surinam 119 (30 mg Cl/l).

2. **Oedogonium capilliforme** Kützing

Hirn 1900, p. 107; Tiffany 1930, p. 81; Gemeinhardt 1939, p. 123—124.

Dioecious, macrandrous; oogonium 1, slightly swollen, obovoid or subobovoid, with a superior pore, 39—45 × 50—60 μ; oospores not filling the oogonium, ovoid-globose, cylindric-globose, sub-globose or globose, 37—43 × 40—50 μ, spore-wall smooth; vegetative cells 25—32 μ in diam., $1^1/_2$—4 × as long as broad; antheridia 2—5 in a row, each with two sperms, division horizontal. — Fig. 2. *21*.

Distribution: U. S. A. (Missouri, Iowa, Ohio, Missisippi, Illinois), Europe (France, Russia, Sweden, Germany), South Africa, Patagonia, Antilles (Curaçao).

Locality: Curaçao 396a (160 mg Cl/l).

3. **Oedogonium crispum** (Hassall) Wittrock var. **uruguayense** Magnus & Wille

Hirn 1900, p. 164; Tiffany 1930, p. 114; Gemeinhardt 1939, p. 212—213.

Monoecious, macrandrous; oogonia single, obovoid-globose or globose, operculate, division superior, 25—32 × 32—40 μ; oospores globose, almost entirely filling the oogonium, diam. 22—27 u, spore-wall smooth; antheridium one, subepigynous or hypogynous, sperms 2, division horizontal; vegetative cells slightly or not capitellate, 7—14 × 30—70 μ. — Fig. 2. *22—24*.

Distribution: U. S. A. (Pennsylvania, Massachusetts), China, Uruguay, Brazil, Colombia, Surinam.

Locality: Colombia 114, Surinam 119 (30—820 mg Cl/l).

4. **Oedogonium pusillum** Kirchner

Hirn 1900, p. 299—300; Tiffany 1930, p. 161; Gemeinhardt 1939, p. 331—332.

Monoecious, macrandrous; oogonia single or sometimes in pairs, subbiconic-ellipsoid or subbiconic-globose, operculate, division median and wide, 14—17 μ in diam., length 14—21 μ; oospores ellipsoid or globose, slightly constricted in the middle, not entirely filling the oogonium, 9—11×11—14 μ, spore-wall smooth; vegetative cells not capitellate, 3—6 × 10—21 μ; antheridia 1 or 2, with 1 (?) sperm. — Fig. 2. *25.*

Distribution: Europe (Germany, France, Austria, Italy), Africa (Abessynia, Sudan, North-West Africa), Indonesia (Sumatra), U. S. A. (Iowa, Illinois, Massachusetts), Brazil, Surinam.

Locality: Surinam 119 (30 mg Cl/l).

5. **Oedogonium capitellatum** Wittrock

Hirn 1900, p. 149; Tiffany 1930, p. 104; Gemeinhardt 1939, p. 186.

Monoecious, macrandrous; oogonia single, subdepressed or depressed-globose; operculate, division median and narrow, diam. 21—26 μ, length 20—23 μ; oospores subdepressed or depressed-globose, entirely filling the oogonium, diam. 21—23 μ, length 18—21 μ, spore-wall smooth; vegetative cells capitellate, 6—10 × 18—50 μ; antheridia 1—3, hypogynous or sometimes subepigynous, each with one sperm. — Fig. 2. *26.*

Distribution: Europe (Färöer-islands, Denmark, Sweden, Finland), Manschuria, Turkestan, Birma, South-West China, Kaukasus, U. S. A. (Ohio, Illinois, Mississippi, Alabama, Florida, Oklahoma), British Columbia, Brazil (Cearà), Antilles (Curaçao).

Localities: Curaçao 396a, 396b, 397a (125—abt 300 mg Cl/l).

6. **Oedogonium howardii** West

Tiffany 1930, p. 101; Gemeinhardt 1939, p. 180.

Dioecious, macrandrous; oogonia 1—2, mostly globose, also slightly ellipsoid or depressed-globose, division median, distinct, 26—32 μ in diam., length 27—37 μ; oospore filling the oogonium, spore-wall smooth; vegetative cells capitellate, 7—14 μ in diam., $1^1/_2$—5 × as long as broad, basal cells subspherical-hemispherical; antheridia 1—16 in a row, each with two sperms. — Fig. 2. *27, 28.*

Distribution: U. S. A. (Ohio, Illinois, Florida, Oklahoma), Antilles (Barbados, Puerto Rico, Curaçao, Bonaire, St. Martin).

Localities: Bonaire 52f, 383; Klein Curaçao 387; Curaçao 89, 390, 397a, 397c; St. Martin 529a (125—3200 mg Cl/l).

In the material from Klein Curaçao 387 akinetes were found (Fig. 2. *28*), growing 3—6 intercalary in a row.

7. **Oedogonium infimum** Tiffany

Tiffany 1930, p. 101; Gemeinhardt 1939, p. 177.

Dioecious, macrandrous; oogonium 1, globose or depressed-globose, operculate, division at the lowest extremity of the oogonium, diam. 34—40 μ, length 30—40 μ; oospores filling the oogonium, membrane smooth; antheridia 1—10; sperms two (not observed); vegetative cells distinctly capitellate, (35—)60—140 μ × 12—20 μ; basal cell of filament sub-hemispherical, not elongated. — Fig. 2. *29.*

Distribution: U. S. A. (Iowa, Ohio), Antilles (Curaçao).

Localities: Curaçao 396a, 396b, 397c (160—280 mg Cl/l).

CLADOPHORALES

Cladophoraceae

Rhizoclonium Kützing

Rhizoclonium hieroglyphicum (C. A. Agardh) Kützing

Heering 1921, p. 20; Prescott 1951, p. 142; Tiffany & Britton 1952, p. 46.

Filaments long, unbranched, without lateral rhizoids; 10—50 μ in diam., cells (1—2)2—10(—14) × as long as broad; cell-walls usually thin in the most common form, but often of variable thickness. — Fig. 2. *30, 31.*

Distribution: Cosmopolitic; common in hard water.

Localities: Bonaire 48a, 53c, 53d; Klein Bonaire 61b; Curaçao 67, 67a, 72A, 391, 395; Aruba 93b; Barbuda 674; St. Martin 532, 538, 538a, 539, 539a; Anguilla 544. (430—2650 mg Cl/l).

The specimens from St. Martin 538, 538a, 539, 539a and Bonaire 53c, 53d consist of filaments composed of two types of cells, long cylindric cells, 14—25 μ in diam., 1—4 × as long as broad, and irregularly swollen cells 20—40 μ in diam., 1—2 × as long as broad. The filaments composed of irregular cells are twisted. The cell-walls are rather thick, viz. 3—9 μ.

In the material from Bonaire 48a the diam. varies from 10—50 μ, the length is 2—4 × the diam. The cell-walls are very thick, in filaments of 10 μ ± 1.5 μ, in filaments of 50 μ 9—14 μ thick. Also very few one-celled lateral rhizoids occur.

Pithophora Wittrock

Thallus filamentous, monosiphonous, with branches arising at right angles to the main axis, usually very close to the terminal cell-walls. Cells cylindrical or a little swollen, multinucleate. Chloroplast a parietal net, containing many pyrenoids. Reproduction asexual by akinetes, terminal or intercalary in the filaments. Akinetes dividing into two parts, of which one develops a short rhizoid, the other the initial cauloid filament of the future plant.

Sterile plants resembling very much *Cladophora,* differing from this genus by its rhizoids and its branches often opposite, arising at right angles to the main axis.

A. Akinetes all cask-shaped . . . . *Isosporeae*
B. Akinetes cylindrical, irregular or cask-shaped . . . . . *Heterosporeae*

A. *Isosporeae.*
- a. Filaments slender, main filaments of fertile plants (39—)45—75(—89) μ in diam.; in middle of akinete 1,2—3 × diam. at the base; end-walls of akinetes even . . . . **1. P. oedogonia**
- b. Filaments stouter, main filaments (58—)85—110(—129) μ in diam.; diam. in middle of akinete 1,2—1,8(—2) × diam. at the base; end-walls of akinetes rounded . . . . **2. P. aequalis**

B. *Heterosporeae.*
- a. Main filaments (58—)80—115(—164) in diam. . . . . **3. P. polymorpha**
- b. Main filaments (90—)100—140(—180) in diam. . . . . **4. P. zelleri**

1. Pithophora oedogonia (Montagne) Wittrock

Wittrock 1877, p. 55—58; Collins 1909, p. 363; Heering 1921, p. 62; Tiffany & Britton 1944, p. 42; Prescott 1951, p. 140; Glassmann 1952,

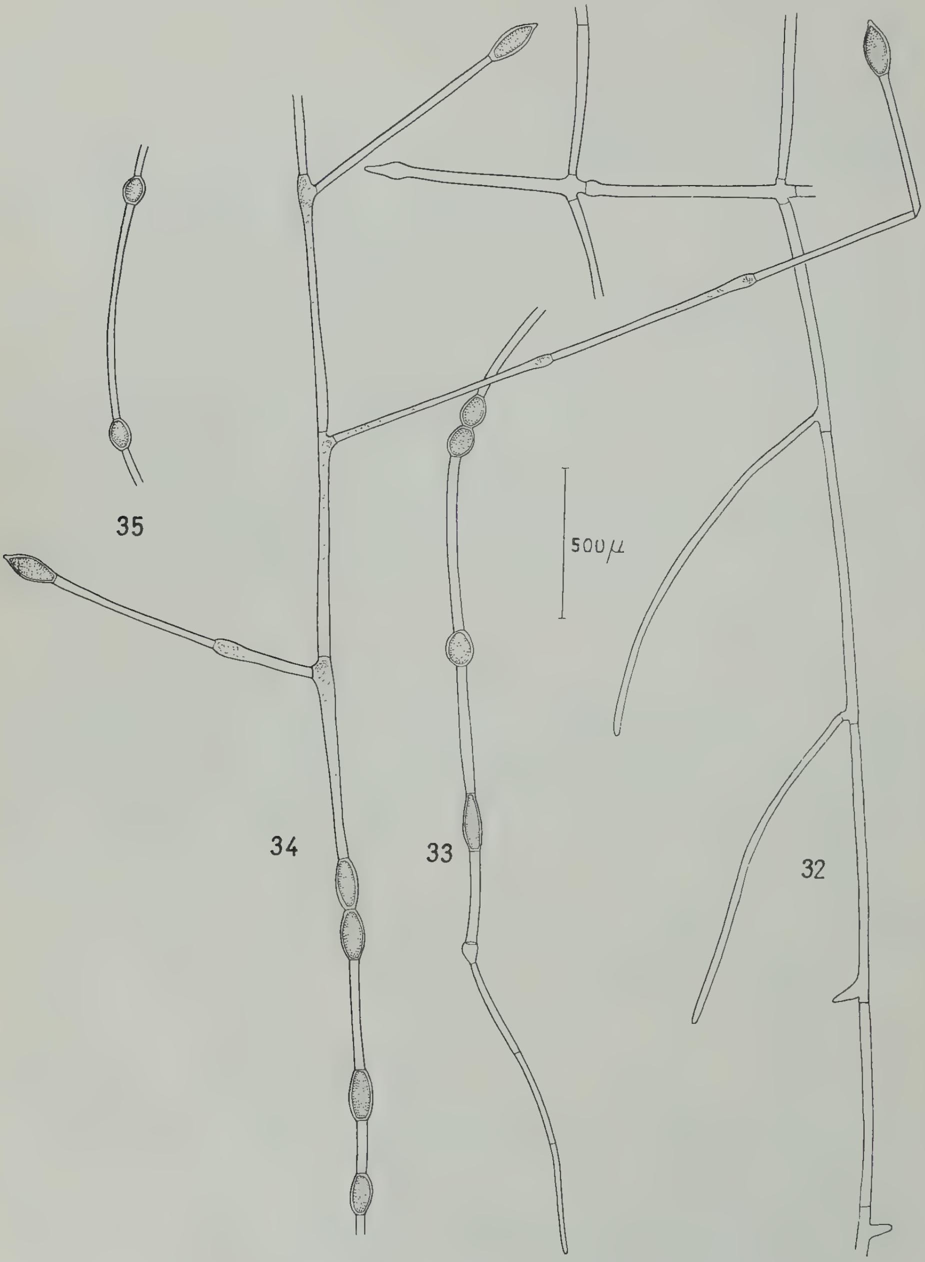


Fig. 3. *32—35. Pithophora oedogonia* from sta. 383, Bonaire.

p. 737; Tiffany & Britton 1952, p. 48. — Exsicc.: Collins, Holden & Setchell, Phycotheca Boreali-Americana 1636 (1909). — *Pithophora kewensis* Wittrock 1877, p. 52—55; Wolle 1887, p. 131; Collins 1912, p. 99; Heering 1921, p. 62. — Exsicc.: Collins, Holden & Setchell, Phycotheca Boreali-Americana 1636 (1909) and 2027 (1913). — *Pithophora affinis* Nordstedt 1878, p. 19. — Exsicc.: Heller, Plants of the Hawaiian Islands, collected on the Island Oahu, at Diamond Head, 2285 (1895).

Main filaments of sterile plants (60—)70—80(—117) μ in diam., with branches of first and sometimes of second order. Branches of first order solitary or sometimes opposite, branches of second order solitary; diam. of branches (36—)40—50(—71) μ. Main filaments of fertile plants (39—) 45—75(—89) μ, with branches of first and sometimes, but very few, of second order. Branches of first order mostly solitary, very few opposite; diam. of branches (25—)30—40(—46) μ. Akinetes intercalary, sometimes in pairs, but usually in regular alternation with vegetative cells, and terminal, all cask-shaped. Akinetes in main filaments 107—210 × 71—150 μ, 1.0—1.2 × as long as broad, diam. in middle of akinete 1.2—2.2 × diam. at the base of akinete. Akinetes in branches 117—190 × 58—118 μ, 1.5—2.6 × as long as broad; diam. in middle of akinete 1.6—3 × diam. at the base. Terminal akinetes cask-shaped with blunt-conical apex, 107—236 × 54—75 μ, 1.7—3.3 × as long as broad, diam. in the middle of akinete 1.5—2.9 × diam. at the base. Wall of akinetes 4—14 μ thick. — Fig. 3. *32—35.*

Distribution: Europe (greenhouses, tropical aquaria), U. S. A. (Ohio, Illinois, Wisconsin, New Yersey, Nebraska, Pennsylvania), Bermuda, Antilles (Puerto Rico, St. Martin, Bonaire, Curaçao, Aruba), Caroline Islands, Hawaii, India, Burma.

Localities: Bonaire 383; Curaçao 75a; Aruba 104a; St. Martin 529 (105—1345 mg Cl/l).

2. **Pithophora aequalis** Wittrock

Wittrock 1877, p. 50—52; Frémy 1938, p. 22—24. — Exsicc.: Ferguson, Ceylon Algae 47.

Main filaments (58—)85—110(—129) μ diam. Branches of three, sometimes of four orders, opposite or solitary, (36—)55—75(—86) μ in diam. Akinetes intercalary always solitary and regularly alternating with vegetative cells, and terminal, all cask-shaped, with somewhat rounded ends. Akinetes in main filaments very few, diam. in the middle of the akinete 1.2—1.4 × diam. at the base. Akinetes in branches 75—114 × 114—171 μ, 1.4—2 × as long as broad, diam. in the middle of the akinete 1.2—1.8(—2) × diam. at the base. Terminal akinetes few, cask-shaped with blunt-conical to broadly rounded apex. Wall of akinetes 3.5—7.5 μ thick. — Fig. 4. *36—38*, 5. *39—43.*

Distribution: Ceylon, Venezuela, Antilles (St. Croix, St. John, Curaçao, Aruba).

Localities: Curaçao 391; Aruba 93c; Curaçao 88b(?) (510—760 mg Cl/l).

The description was made from the specimen from Curaçao 391. The size of its vegetative parts and the size and form of the akinetes agree fairly well with Wittrock's description. Also the akinetes, as in Wittrock's

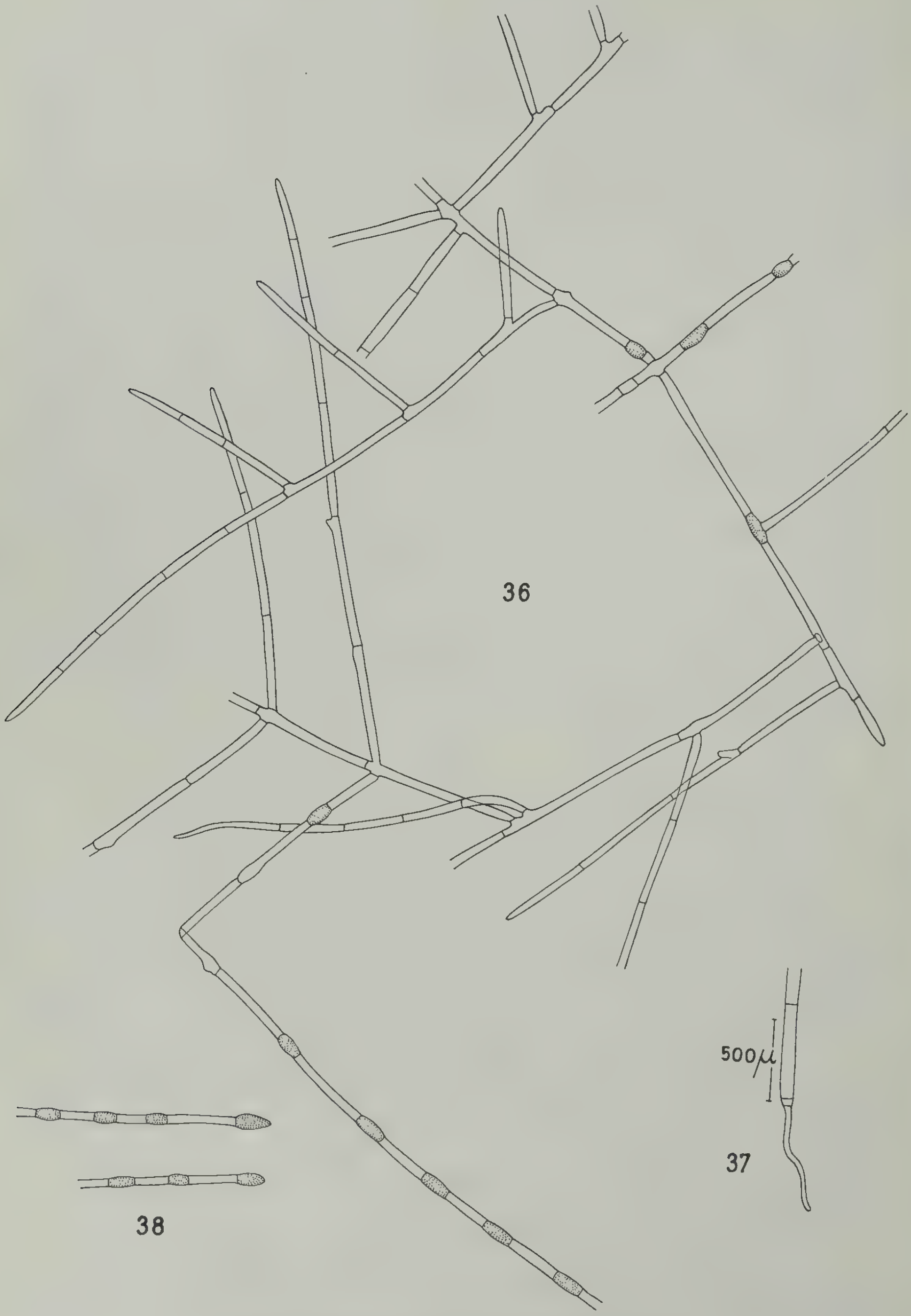


Fig. 4. *36—38. Pithophora aequalis* from sta. 391, Curaçao.

description, are single. The mode of ramification of this specimen, however, differs much from Wittrock's description. According to him there are plants with numerous short branches of only one order and plants with long branches of first order and short branches of second order. This specimen has branches of four orders.

Of the material from Curaçao 88b only the form of the akinetes is similar to that given by Wittrock. This specimen was very ripe, many akinetes germinating already, especially the akinetes in the main filaments.

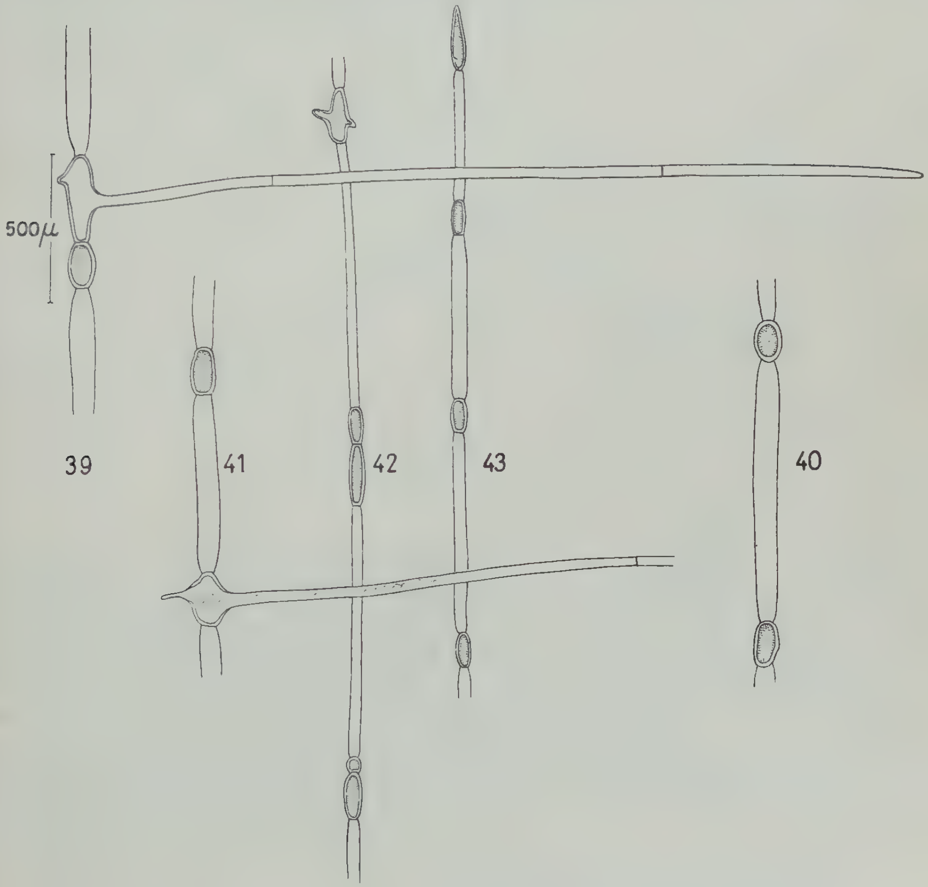


Fig. 5. *39—43. Pithophora aequalis* from sta. 88b, Curaçao.

The thallus, therefore, was much fragmented and it was impossible to detect the mode of ramification. Only branches of the first order could be observed with certainty. It seems useful to give a full description of this specimen:

Main filaments (89—)110—140(—157) μ in diam. Branches (54—) 60—80(—100) μ in diam. Vegetative cells swollen. Akinetes intercalary, then 1, 2, 3 and 4-seriate, and more rarely terminal, all cask-shaped, with

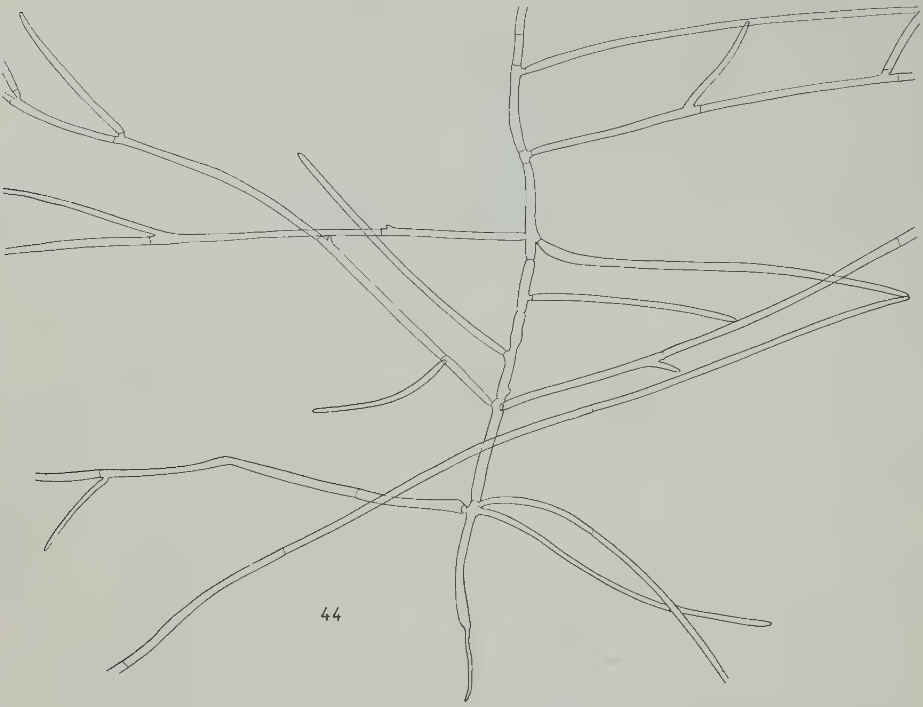


Fig. 6. *44. Pithophora polymorpha.*

rounded ends. Akinetes in main filaments 96—164 × 129—268 μ, 1.0—2.7 × as long as broad, diam. of akinete in middle 1—1.6 × diam. at the base. Akinetes in branches 60—104 × 100—215 μ, 1—2.5 × as long as broad, diam. of akinete in middle 1—2.1 × diam. at the base. Terminal akinetes few, cask-shaped with blunt-conical apex. Wall of akinetes 10—18 μ thick.

The specimen described by Frémy has branches of three orders. The diam. of the main filament is 140—160 μ, of the branches about 55—155 μ. The intercalary akinetes are single, slightly swollen, with rounded ends. They were not found in the main filament. Size of akinetes about 69—115 × 112—184 μ.

3. **Pithophora polymorpha** Wittrock

Wittrock 1877, p. 62—64; Wittrock 1880, p. 113—122; Dixit 1937, p. 20. — *Pithophora varia* Wille, in Collins, Holden & Setchell, Phycotheca Boreali-Americana 983 (1902); Collins 1909, p. 364; Tiffany & Britton 1944, p. 42; Prescott 1951, p. 140; Tiffany & Britton 1952, p. 48.

Main filaments (58—)80—115(—164) μ in diam., with branches of two orders or of three (sometimes four) orders. Branches of first order opposite or solitary, of second order opposite or solitary, branches of third and fourth order solitary; diam. of branches (35—)40—70(—114) μ. Terminal cells 32—60 × 200—900 μ. Akinetes intercalary and terminal. Akinetes in main filaments usually irregular, sometimes cylindrical or cask-shaped, 1, 2 or 3-seriate, 71—160 × 114—286 μ, 0.8—4.2 × as long as broad. Akinetes in branches irregular, cylindrical or cask-shaped, 1, 2 or 3-seriate, often in regular alternation with vegetative cells, 39—132 × 89—265 μ, (0.8—)2.0—3.0 × as long as broad. Terminal akinetes usually cask-shaped with blunt-conical apex or broadly rounded apex, sometimes irregular, 54—89 × 143—261 μ, 2.1—3.9 × as long as broad. Wall of akinetes 3.5—13 μ thick. — Fig. 6. *44*, 7. *45, 46, 48.*

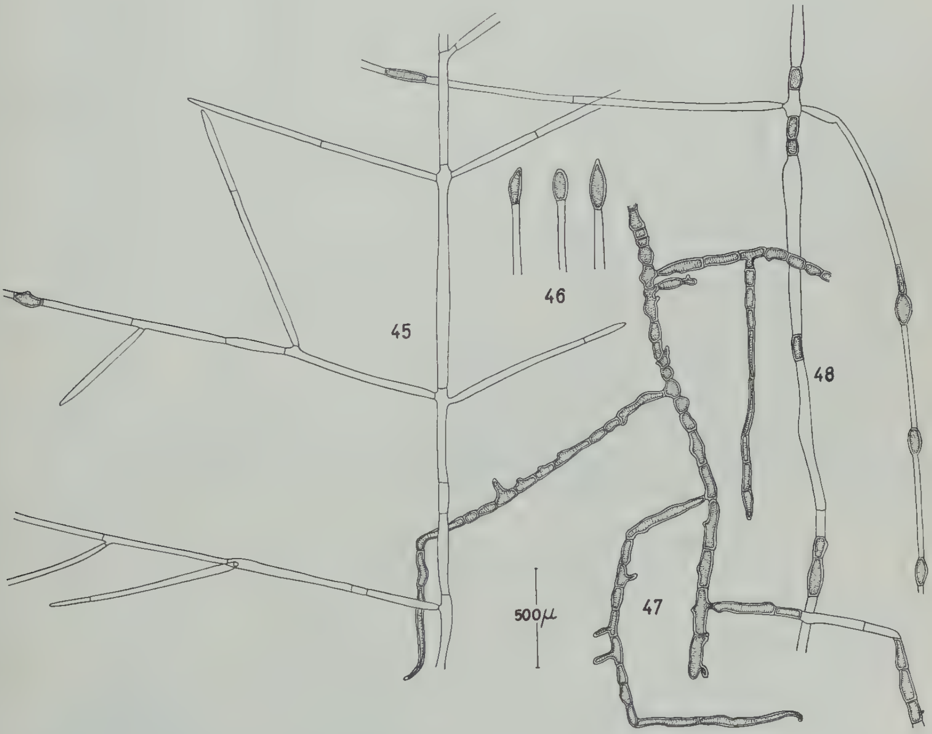


Fig. 7. *45, 46, 48. Pithophora polymorpha; 47. Pithophora polymorpha* var. *polyspora* from sta. 510, St. Eustatius.

Distribution: U. S. A. (Minnesota, Illinois, Michigan), Antilles (Puerto Rico, St. Martin, Margarita, Curaçao), India, Ceylon (forma magis ramosa Wittrock).

Localities: Margarita 17; Curaçao 391; St. Martin 538a, 539a (270—710 mg Cl/l).

The specimen from Curaçao has branches of third, sometimes of fourth order. The akinetes are generally single, sometimes 2—3-seriate. Most akinetes are cask-shaped.

var. **polyspora** nov. var.

Acinetae seriatae catenam saepe longam formantes.

The variety is characterized by long, uninterrupted chains of irregular akinetes. Often a whole plant consists of a chain of akinetes only. The remaining characters coincide with the above description. — Fig. 7. *47*.

Localities: St. Eustatius 510 and 513 (35—2100 mg Cl/l). The environmental conditions of these two stations were entirely different; this fact suggests that this variety is not caused by different ecological factors.

4. Pithophora zelleri (v. Martens) Wittrock

Wittrock 1877, p. 64—66.

Main filaments (90—)100—140(—180) μ in diam., with branches of first and second order, sometimes of third order. Branches of first order opposite or solitary, branches of second and third order solitary. Diam. of branches 70—125 μ. Terminal cells very long and slender, 1500—6000 μ long, 45—75 μ in diam. Akinetes intercalary and very few terminal. Akinetes in main axis usually cylindrical or slightly and mostly irregularly swollen; often in pairs; often in regular alternation with vegetative cells; 90—135 × 140—290 μ, 1.3—2.3 × as long as broad. Akinetes in branches cask-shaped, cylindrical or irregular; sometimes in pairs; usually in regular alternation with vegetative cells; 70—110 × 140—290 μ, 1.6—2.3 × as long as broad. Terminal akinetes very few, cask-shaped with blunt-conical apex. — Fig. 8. *49—56*.

Distribution: Japan, Antilles (Dog Island).

Locality: Dog Island 546 (1410 mg Cl/l).

According to Wittrock the most remarkable character of *P. zelleri* is that the akinetes in the principal filament occur as a rule in pairs, the upper akinete of a pair being cask-shaped, the lower one being cylindrical. Although such pairs were found in this specimen, many akinetes were single as well.

CHLOROCOCCALES

Coelastraceae

Coelastrum Naegeli

1. Coelastrum cambricum Archer

Borge 1896, p. 7; Collins 1909, p. 173; Lemmermann, Brunnthaler & Pascher 1915, p. 196; Borge 1918, p. 83; Borge 1925, p. 8; Gauthier-Lièvre 1931, p. 248; Skuja 1949, p. 69; Prescott 1951, p. 229; Tiffany & Britton 1952, p. 113.

Cells 10—12 angular, with a single truncate projection on the outer

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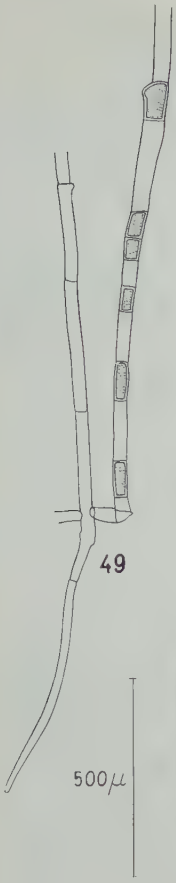
Fig. 8. *49—56. Pithophora zelleri* from sta. 546, Dog Island (near Anguilla); *57. Coelastrum cambricum* from sta. 75, Curaçao; *58. Coelastrum scabrum* from sta. 390, Curaçao; *59, 60. Oocystis eremosphaeria* from sta. 75, Curaçao; *61, 62. Gloeotaenium loitlesbergerianum* from sta. 75, Curaçao; *63, 64. Tetraedron bifurcatum* from sta. 529, St. Martin; *65, 66. Tetraedron regulare* from sta. 397d, Curaçao; *67. Zygnemopsis americana* from sta. 397d, Curaçao; *68. Spirogyra distenta* from sta. 500, Nevis.



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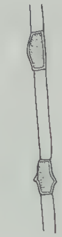

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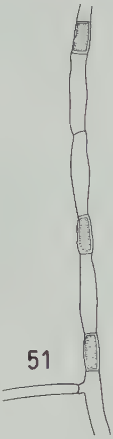

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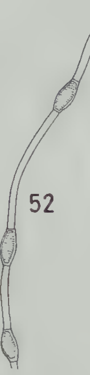

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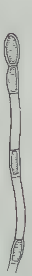

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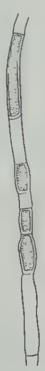

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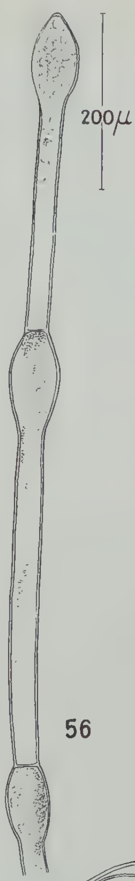

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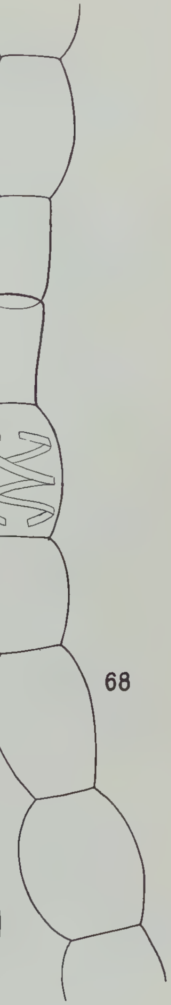

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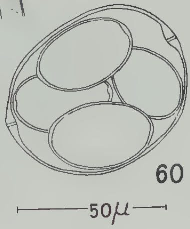

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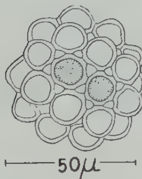

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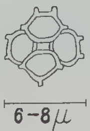

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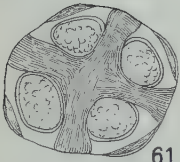

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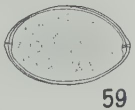

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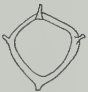

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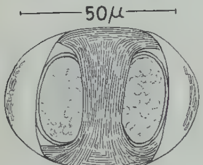

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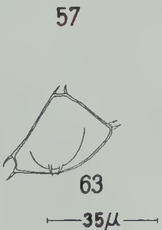

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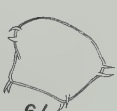

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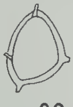

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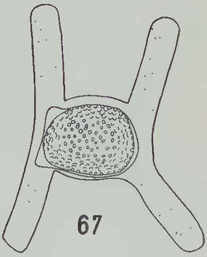


67

face, 7—13 μ in diam. Colonies composed of 8—128 cells, each cell connected with the neighbouring cells by 6 short connections so that triangular intercellular spaces result. — Fig. 8. *57*.

Distribution: Europe, North Africa, Ceylon, Burma, India, Australia, U. S. A., Brazil, Antilles (Puerto Rico, Curaçao).

Locality: Curaçao 75 (450 mg Cl/l).

2. Coelastrum scabrum Reinsch

Lemmermann, Bruthaler & Pascher 1915, p. 197; Prescott 1951, p. 230.

Cells angular-globose, with 3—6 short, wart-like and truncate projections on the outer surface, 6—10 μ in diam. Colonies composed of 4—16 cells Fig. 8. *58*.

Distribution: South Africa, South America, U. S. A. (Michigan), Antilles (Curaçao).

Locality: Curaçao 390 (725 mg Cl/l).

Oocystaceae

Oocystis Naegeli

Oocystis eremosphaeria G. M. Smith

Prescott 1951, p. 244.

Often solitary, sometimes in a group of 2, 3, 4 (very seldom 8) within the old mother cell-wall; cells ellipsoid, poles with a nodular thickening; chloroplasts numerous, about 25—60 parietal lenticular discs; cells 17—32 μ in diam., 21—41 μ long. — Fig. 8. *59, 60*.

Distribution: U. S. A. (Michigan, Wisconsin), Antilles (Curaçao).

Locality: Curaçao 75 (450 mg Cl/l).

Gloeotaenium Hansgirg

Cells spherical-ellipsoid, forming flat, round-quadrangular-ovate colonies of 2 or 4 cells enclosed within the persistent mother-cell-wall. Cells separated within the colony by dark coloured masses of mucilage containing calcium-carbonate, appearing in 2-celled colonies as a dark transverse band, in 4-celled colonies as a cross. Between the cells and the colonial membrane a cap of dark mucilage. Chloropast massive, form indistinct.

Gloeotaenium loitlesbergerianum Hansgirg

Collins 1909, p. 310; Lemmermann, Brunnthaler & Pascher 1915, p. 214; Tiffany & Britton 1942, p. 45; Skuja 1949, p. 70; Prescott 1951, p. 247, 248; Tiffany & Britton 1952, p. 115.

Characteristics as described for the genus. Cells 14—18 × 18—29 μ; 4-celled colonies 46—54 × 50—58 μ, 2-celled colonies 39—46 × 54—61 μ. — Fig. 8. *61, 62*.

Distribution: Europe, India, Burma, U. S. A., Antilles (Curaçao, Trinidad, Puerto Rico), Surinam.

Localities: Curaçao 75, Surinam 406 (18—450 mg Cl/l).

Tetraedron Kützing

1. **Tetreadron bifurcatum** (Wille) Lagerheim

Collins 1909, p. 165; Lemmermann, Brunnthaler & Pascher 1915, p. 156; Borge 1918, p. 81; Borge 1925, p. 7; Skuja 1949, p. 63; Prescott 1951, p. 263; Tiffany & Britton 1952, p. 119.

Cells irregularly tetrahedral, the angles 2-lobed, each lobe with a short spine. The margins of the cell between two lobes somewhat concave. Diam. of cells without spines 25—32 μ, with spines 32—39 μ. — Fig. 8. *63, 64.*

Distribution: Europe, India, Burma, U. S. A., Cuba, Brazil, Antilles (Puerto Rico, St. Martin).

Locality: St. Martin 529 (105 mg Cl/l).

2. **Tetraedron regulare** Kützing

Lemmermann, Brunthaler & Pascher 1915, p. 150; Prescott 1951, p. 269; Tiffany & Britton 1952, p. 119.

Cells tetragonal, pyramidal; sides convex; each angle narrowly rounded and provided with a short, blunt spine; 8.5—12 μ in diam. — Fig. 8. *65, 66.*

Distribution: Cosmopolitic.

Locality: Curaçao 397d (510 mg Cl/l).

According to Tiffany & Britton the diam. may vary between 14—45 μ.

ZYGNEMATALES

Zygnemataceae

Zygnemopsis Skuja

Zygnemopsis americana Transeau

Transeau in Transeau, Tiffany, Taft & Li 1934, p. 215; Kolkwitz & Krieger 1941, p. 284; Transeau 1951, p. 53—54; Prescott 1951, p. 327.

Vegetative cells 9—12 × 30—120 μ; conjugation scalariform; zygospores in the wide conjugation-tubes and extending far into each gametangium; gametangia filled with a transparent gel; zygospores irregularly quadrangular-ovoid; with rounded angles, 20—30 × 30—40 μ; parthenospores; median spore-wall minutely scrobiculate. — Fig. 8. *67.*

Distribution: U. S. A. (Michigan, Wisconsin), Canada (Ontario), Antilles (Curaçao).

Locality: Curaçao 397a (125 mg Cl/l).

Spirogyra Link

A. End-walls of cells plane . . . . *Conjugata*
B. End-walls of cells replicate . . . . *Salmacis*

A. *Conjugata*

a. Mesospore smooth.
  1. Vegetative cells 40—45 μ in diam. Zygospores with broadly rounded ends **1. S. distenta**
  2. Vegetative cells 40—46 μ in diam. Zygospores with sharply rounded ends **2. S. fuellebornii**
  3. Vegetative cells 65—88 μ in diam. . . . . **3. S. nitida**

b. Mesospore sculptured.
  1. Mesospore with irregular, longitudinally undulating ribs **4. S. fluviatilis**
  2. Mesospore finely punctate . . . . **5. S. punctiformis**

B. *Salmacis*

a. Mesospore smooth . . . . **6. S. pseudospreiana**
b. Mesospore minutely punctate . . . . **7. S. minutipunctata**

1. **Spirogyra distenta** Transeau

Transeau 1934, p. 420; Krieger 1944, p. 350; Transeau 1951, p. 174 — *S. decimina* (Müll.) Kütz. var. *inflata* Fritsch & Stephens 1921, p. 21, fig. 20.

Vegetative cells 40—54 μ in diam., 81—201 μ long, with plane end-walls; chromatophores 2—3, making 1½—2 turns; conjugation scalariform; conjugation-tubes distinct, formed by both gametangia; fertile cells cylindrical; conjugating cells 60—114 μ long; non-conjugating cells mostly regularly or irregularly inflated; zygospores ellipsoid with broadly rounded ends, cylindrical-globose, diam. 41—53 μ, 51—70 μ long; mesospore smooth, brown, 2 μ thick. — Fig. 8, *68*, 9, *69—72*.

Distribution: Antilles (Nevis, Aruba), South America (Venezuela), U. S. A. (Illinois, Ohio, Iowa, Kentucky), South Africa (Quingolo).

Localities: Aruba 97; Paraguaná (Ven.) 105; Nevis 500 (60—140 mg Cl/l).

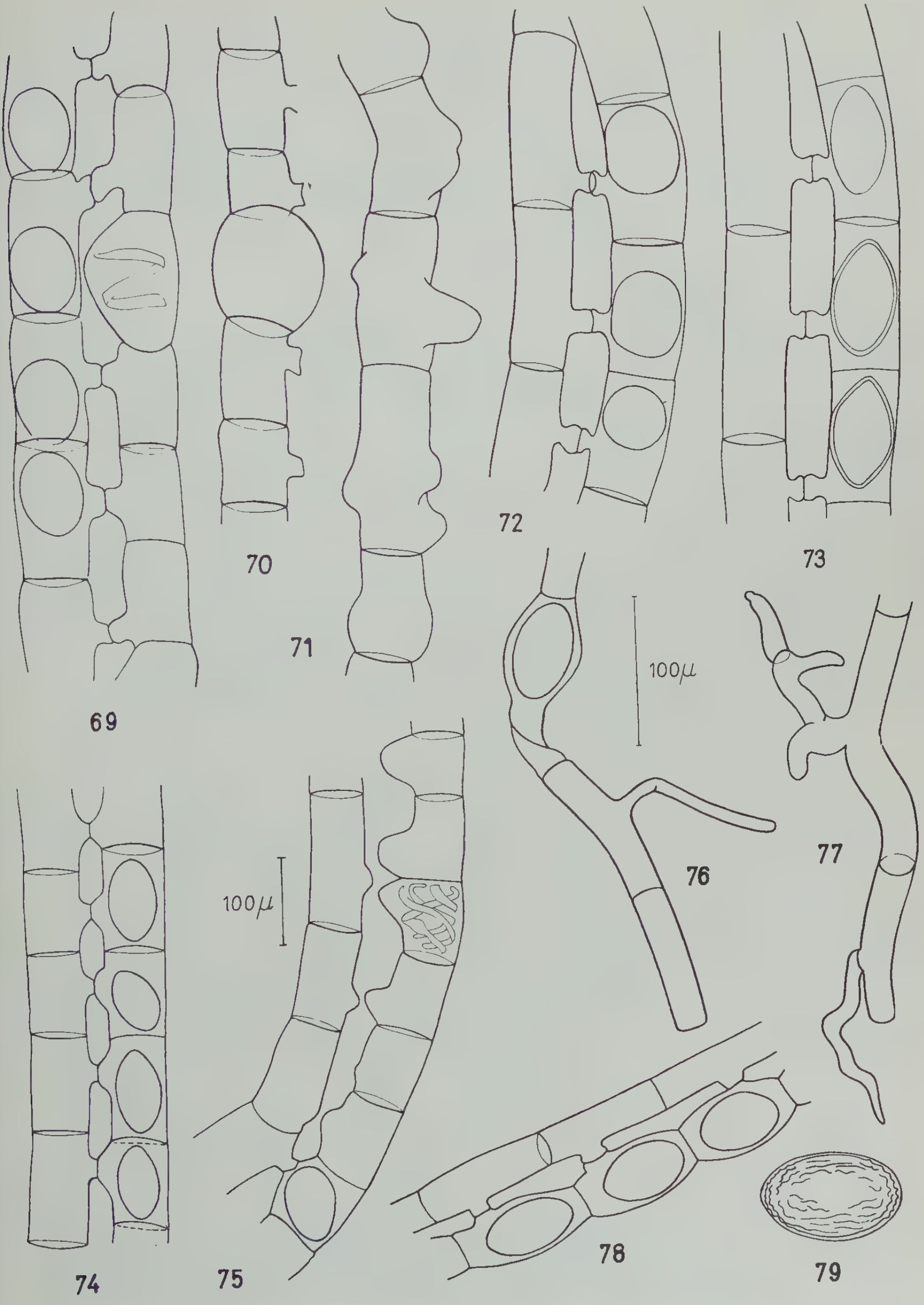
Krieger (1944, p. 350) mentions as a possible synonym of *S. distenta* Transeau *S. dubia* Kütz. var. *polymorphis* Rao (Rao 1938, p. 346, 347). This seems improbable. Rao does not say anything about inflated sterile cells. Further the fertile cells of *S. dubia* var. *polymorphis* are inflated, of *S. distenta* cylindrical.

The non-conjugating cells of the material from Nevis are regularly inflated, forming more or less ellipsoid or bullate sacs; such cells occur only on the male filaments. The non-conjugating cells of the material from Paraguanà are irregularly inflated, with one or more irregular bulges; the inflated cells occur on both male and female filaments. On both male and female filaments of the material from Aruba occur regularly as well as irregularly inflated non-conjugating cells.

According to Transeau (1951, p. 174) the zygospores of *S. distenta* are ovoid. In this material they are never ovoid, and in the original description of Fritsch (1921, p. 46) the zygospores are ellipsoid (with broadly rounded ends) to cylindrical-globose.

S. distenta Transeau differs from *S. bullata* Jao (Jao, 1935, p. 588, pl. IV, fig. 55) by its size and the number of chromatophores, from *S. hollandia* Taft (Taft 1947, p. 173) by its scalariform conjugation; *S. hollandia* has scalariform as well as lateral conjugation.

Fig. 9. *69—70. Spirogyra distenta* from sta. 500, Nevis; *71—72. Spirogyra distenta* from sta. 105, Paraguaná (Venezuela); *73. Spirogyra fuellebornii* from sta. 397c, Curaçao; *74, 75. Spirogyra nitida* from sta. 397a, Curaçao; *76—79. Spirogyra fluviatilis* from sta. 89, Curaçao.


100μ
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2. Spirogyra fuellebornii Schmidle

Krieger 1944, p. 350; Prescott 1951, p. 315.

Vegetative cells 40—46 μ in diam., 80—170 μ long, with plane end-walls; chromatophores 2—4; conjugation scalariform; conjugation-tubes distinct, formed as much by the male cells as by the female cells; fertile cells cylindrical; zygospores ellipsoid with sharply rounded ends, 40—50 × 52—80 μ; mesospore smooth, brown, ± 2.5 μ thick. — Fig. 9, *73*.

Distribution: Central and South Africa, Burma, India, U.S.A. (Wisconsin), Antilles (Curaçao).

Locality: Curaçao 397c (280 mg Cl/l).

3. Spirogyra nitida (Dillwyn) Link

Dillwyn 1809, Taf. IV; Link 1820, p. 262; litterature and synonyms in Kolkwitz & Krieger 1941, p. 51 and Krieger 1944, p. 353; Skuja 1949, p. 102; Prescott 1951, p. 318; Transeau 1951, p. 171 — *Spirogyra hymerae* Britton et Smith, 1942, p. 70.

Vegetative cells 65—88 μ diam., 104—216 μ long, with plane end-walls; chromatophores 3—5, making 1½—4 turns; conjugation scalariform, conjugating cells in long, uninterrupted rows; conjugation-tubes distinct, formed as much by the male cells as by the female cells; fertile cells cylindrical; conjugating cels 62—73 μ diam., 65—156 μ long; non-conjugating cells cylindrical and inflated on the conjugating side of the filament; zygospores ellipsoid with sharply rounded ends, 55—62 μ diam., 78—91 μ long; mesospore smooth, brown, 2.5 μ thick. — Fig. 9. *74, 75*.

Distribution: Europe, North Asia, U. S. A., India, Burma, China, North and East Africa, Madagascar, Argentina, Antilles (Curaçao).

Locality: Curaçao 397a (125 mg Cl/l).

S. nitida differs from *S. distenta* Transeau by its broader cells and by its ellipsoid spores, *S. distenta* having cylindrical spores; from *S. neglecta* (Hass.) Kütz. by its larger cells and by its ellipsoid zygospores with sharply rounded ends; *S. neglecta* having ellipsoid zygospores with broadly rounded ends; from *S. setiformis* (Roth) Kütz. by its narrower cells.

4. Spirogyra fluviatilis Hilse emend. Skuja

Hilse 1863, 1476 (exsicc.); Wolle 1887, p. 216, T. 136, fig. 13; Borge 1913, p. 27; Skuja 1928, p. 106, T. I, fig. 5—7; Cedercreutz 1930, p. 131; Czurda 1932, p. 199, fig. 213; Krieger 1944, p. 406; Prescott 1951, p. 314, pl. 73, fig. 4—5; Transeau 1951, p. 184, pl. XXX, fig. 5 — *S. fluviatilis* forma Fritsch & Rich 1928, p. 49, fig. 12 D—G.

Vegetative cells 25—28 μ in diam., 77—245 μ long, with plane end-walls; 3—4 chromatophores, making ½—4 turns; conjugation scalariform; conjugation-tubes formed by the male gametangia only or almost only; fertile cells inflated, diam. 46—54 μ; conjugating cells 115—223 μ long; zygospores ellipsoid with rounded ends, 33—39 μ in diam., 54—66 μ long; mesospore with irregular longitudinally undulating ribs, 3 μ thick, brown, exospore smooth, hyaline, 1 μ thick; non-conjugating cells cylindrical; very often the conjugation-tube of a non-conjugating cell forms a branched or not-branched rhizoid. — Fig. 9. *76—79*.

Distribution: Europe, Belgian Congo, China, India, U. S. A., Antilles (Curaçao).

Locality: Curaçao 89 (3200 mg Cl/l).

This species grows in ponds and streams, at first attached to underwater objects, later floating free; characteristic are the conjugation-tubes growing into rhizoids.

According to Transeau (1951, p. 185) the plants described by Czurda (1932, p. 199) as *S. fluviatilis* Hilse are allied to *S. smithii* Transeau. Krieger follows Czurda's description. Czurda described two forms of different size, with ellipsoid spores and 3—5 chromatophores and the conjugation-tubes formed by the male cells. His illustration, however, shows two chromatophores and tubes formed by both gametangia.

On the other hand Skuja (1928, p. 106) describes plants with 3—6 chromatophores and the conjugation-tube formed mainly by the male cell. His illustrations agree with his description.

Also, according to Transeau, the description by Wolle (1887, p. 216) and by Borge (1913, p. 27) establish the species. Hilse only described a vegetative form. Wolle, however, does not say anything about the mesospore and the conjugation-tubes, and his illustration which suggests the conjugation-tubes being formed as much by the male as by the female cell is rather schematic. Nor does Borge say anything about the mesospore and the conjugation-tubes, but his illustration suggests the conjugation-tubes being formed by the male cells mainly.

So, after all, Skuja gives the first extensive and reliable description and illustrations. With those the present specimen agrees.

S. fluviatilis differs from *S. grosii* Schmidle in having narrower cells; from *S. smithii* Transeau in having no inner reticulate mesospore; from *S. dictyospora* Jao in having no reticulate mesospore.

5. **Spirogyra punctiformis** Transeau

Transeau 1914, p. 294, pl. 26, fig. 7; Czurda 1932, p. 165, fig. 168; Krieger 1944, p. 388, f. 576; Transeau 1951, p. 200, pl. XXXLV, fig. 5—6.

Vegetative cells 30—39 μ in diam., 236—295 μ long, with plane endwalls; 1—2 chromatophores, making 4—8 turns; conjugation scalariform, conjugation-tubes formed by the male gametangia mainly; fertile cells inflated, 45—51 μ in diam., 90—195 μ long; pairs of conjugating cells separate or two together, never forming long chains; zygospores cylindrical-ovoid-ellipsoid with broadly rounded ends, diam. 42—48 μ, 59—93 μ long; mesospore yellow, finely punctate. — Fig. 10. *80, 81.*

Distribution: U.S.A. (Iowa, Illinois), Antilles (Nevis).

Locality: Nevis 500 (88 mg Cl/l).

Only very few mature zygospores were present in this material.

S. punctiformis differs from *S. aequinoctialis* G. S. West in having broader cells and a smaller number of chromatophores, *S. aequinoctiales* having 2—3 chromatophores; from *S. schmidtii* in having a smaller number of chromatophores, *S. schmidtii* having 2—3 chromatophores.

6. **Spirogyra pseudospreiana** Jao

Jao 1935, p. 608, T. 9, fig. 103; Krieger 1944, p. 437, fig. 696; Transeau 1951, p. 211 — *Spirogyra croasdaleae* Blum 1943, p. 783.

Vegetative cells 16—23 μ in diam., 156—416 μ long, with replicate end-walls; one chromatophore, making 2½—10 turns; conjugation scalariform; conjugation-tubes often formed by the male gametangia only, often by the female gametangia as well; fertile cells inflated mainly on the conjugating side, diam. 30—44 μ; conjugating cells 104—273 μ long; zygospores ellipsoid with rounded ends; 26—31 μ in diam., 44—78 μ long; mesospore smooth, yellowish-brown at maturity, 2.5 μ thick. — Fig. 10. *82*, 11, *83*.

Distribution: South America (Paraguaná-peninsula, Venezuela), China.

Locality: Paraguaná 105 (140 mg Cl/l).

S. pseudospreiana Jao differs from *S. frigida* Gay in having cylindrical non-conjugating cells, *S. frigida* having inflated non-conjugating cells; from *S. austriaca* Czurda by having broader cells and ventricose fertile cells, *S. austriaca* having cylindrically swollen fertile cells; from *S. inflata* (Vauch.) Kütz. in having no lateral conjugation.

7. **Spirogyra minutipunctata** nov. spec.

Cellulis vegetativis 18—23 μ latis, 200—500 μ longis, dissepimentis replicatis; chromatophoro uno, anfractibus 3—10; conjugatione scalariformi; cellulis fructiferis valde inflatis maxime in conjugationis latere, 37—50 × 150—250 μ; tubulis conjugationis maxime ab cellulis masculinis, sed etiam ab cellulis femininis formatis; zygotis ellipsoideis obtuse terminatis, 29—37 × 41—60 μ; exosporio hyalino ± 0,5 μ crasso, mesosporio brunneo minute punctato ± 2 μ crasso. — Fig. 11. *84—87*.

Localities: Bonaire 35d — *typus*; Curaçao 396b (300—550 mg Cl/l).

In the samples 396a and 396c conjugating, but immature *Spirogyra* was found; the structure of the zygote-wall could not yet be observed, but most probably the specimens belong to *S. minutipunctata*.

S. minutipunctata differs from *S. pseudospreiana* in having a minutely punctate mesospore, *S. pseudospreiana* having smooth mesospore; from *S. inflata* (Vauch.) Kütz. in having no lateral conjugation and in having a minutely punctate mesospore; from *S. kunsamoensis* Hirn in having no lateral conjugation and in the larger diameter of the vegetative cells. In *S. kunsamoensis* the diameter of the cells is 13—17 μ.

CHAROPHYCEAE

CHARALES

Chara Vaillant

H. and J. Groves (1911) described 11 species of *Nitella* and 5 species of *Chara* collected in the West Indies. In the material, collected by

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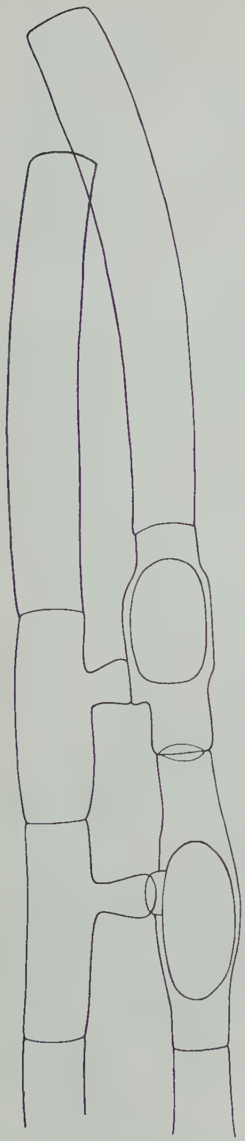
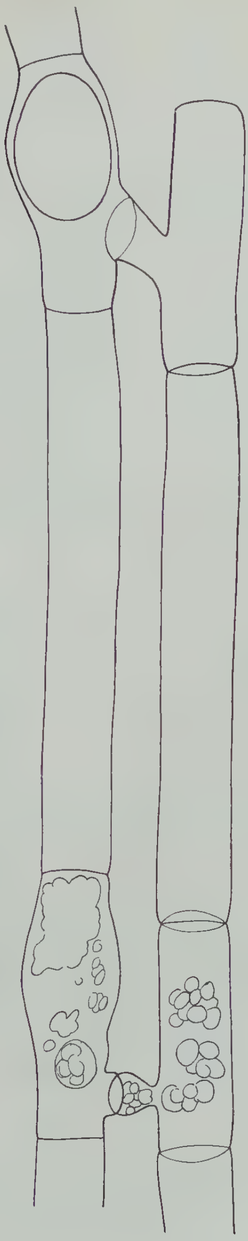
Fig. 10. *80, 81. Spirogyra punctiformis* from sta. 500, Nevis; *82. Spirogyra pseudospreiana* from sta. 105, Paraguaná (Venezuela).



80a



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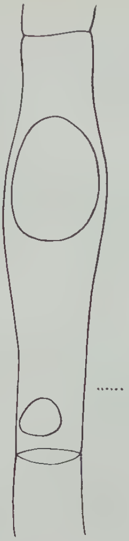
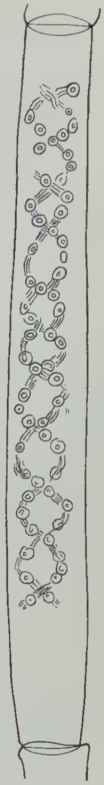
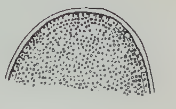


80b





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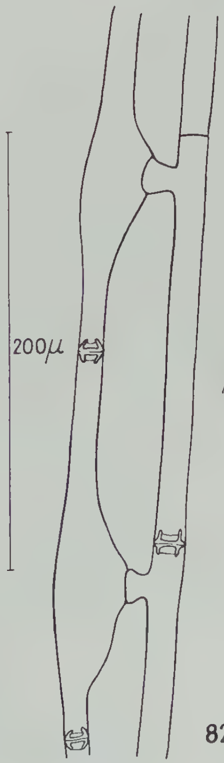

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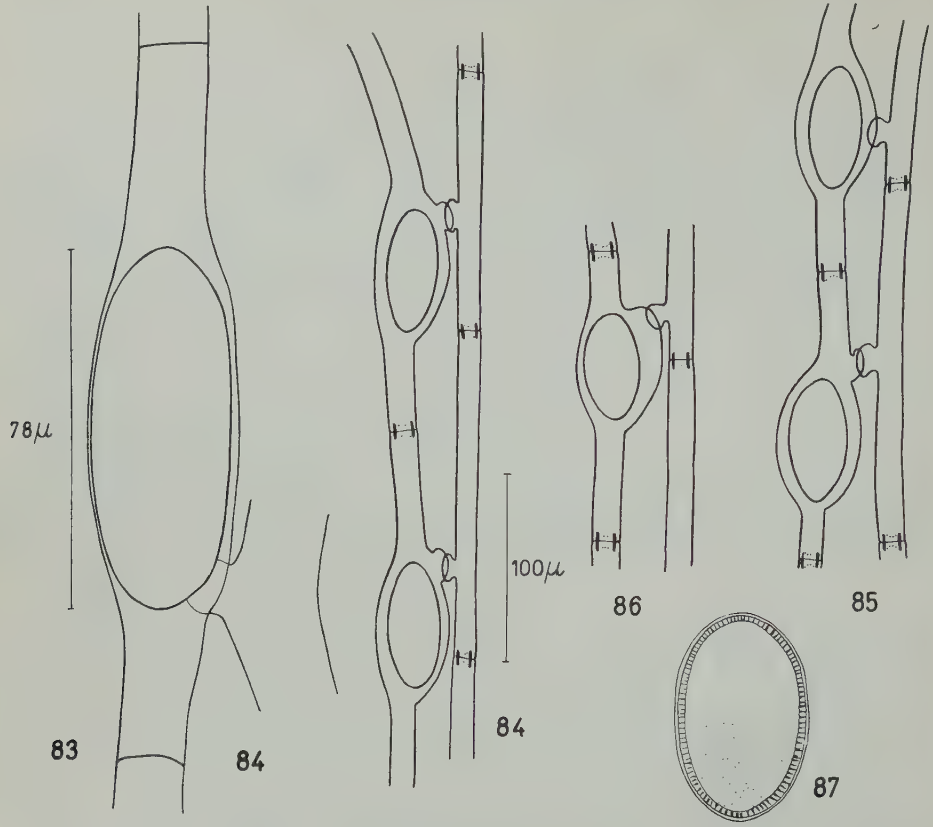

Fig. 11. *83. Spirogyra pseudospreiana* from sta. 105, Paraguaná (Venezuela); *84—87. Spirogyra minutipunctata* nov. spec. from sta. 396b, Curaçao.

Wagenaar Hummelinck, only three species of *Chara,* all of them also described by H. and J. Groves, could be detected.

Zaneveld (1941) made an enumeration of the *Chara*'s collected by Wagenaar Hummelinck in 1930, 1936 and 1937. He distinguished *Chara fibrosa* and seven forms of *Chara zeylanica.* The present author investigated the same material, and according to him Zaneveld's *Ch. fibrosa* must be brought to *Ch. hydropitys.* He did not distinguish as many forms of *Ch. zeylanica* as Zaneveld did, but only four.

1. **Chara hornemanii** Wallmann

Wallmann 1853, p. 60; Braun 1882, p. 122; Nordstedt 1889, p. 33; Allen 1900, p. 300; Robinson 1906, p. 277; H. et J. Groves 1911, p. 38; Britton & Millspaugh 1920, p. 617; Hasslow 1940, p. 288; Horn af Rantzien 1951, p. 355.

Plant robust, dioucious. Cortication of the stem diplostichous, primary cortical cell-series often more prominent than the secondary. Spine cells long, swollen, up to 3 × the stem-diameter, acuminate. Stipulodes in a single row, two opposite one branchlet, long and swollen, acuminate. Branchlets 8—10 in a whorl, composed of 4—7 ecorticate articulations, the ultimate ones very short.

Distribution: Mexico, Bahama Islands, Vieques (Crab Island), Cuba, Key West, Venezuela, Brazil, Antilles (St. Martin, Antigua, Barbuda, Bonaire).

Localities: Bonaire 382a, 382c, 382d, 628; Barbuda (mud-flat south of Codrington Village, 4. VIII. 1955); St. Martin 528, 679 (1890—26200 mg Cl/l).

The specimen from Bonaire 628 is a slender form, which is to be distinguished from *Ch. fibrosa* Ag. ex Bruzelius by being dioecious.

2. **Chara hydropitys** Reichenbach

H. and J. Groves 1911, p. 30; Zaneveld 1940, p. 168—174.

Plant slender, monoecious. Cortication of the stem diplo-triplostichous, primary cortical cell-series equally developed as secondary. Spine cells few, very reduced. Stipulodes in a single row, two opposite each branchlet, long, slender ,acuminate. Branchlets 8—11 in a whorl, composed of 5—7 articulations of which the lowest and the terminal 1—4, or all, are ecorticate. Bract-cells 5—8, long, slender, acuminate, up to 7 × as long as the ripe oogonium, posterior ones about $^2/_3$ × anterior ones. Oogonia produced at the 1—3rd node.

Distribution: India, Ceylon, Malaysia, North Africa, U.S.A., Cuba, Mexico, Brazil, Surinam.

Localities: Surinam 119, Surinam, sandy ditch with shells at Krepi, Charlesburg, North of Paramaribo, 10. VI. 1955, leg. J. S. Zaneveld (30 mg Cl/l).

Zaneveld (1941, p. 142) attributed the specimen from Surinam 119 to *Ch. fibrosa* Agardh ex Bruzelius ssp.? *flaccida* (A. Braun) Zaneveld. Several characteristics of this material are not in accordance with the descriptions of *Ch. fibrosa.* The cortication of *Ch. fibrosa* is diplostichous, that of this specimen diplotriplostichous. The number of stipulodes of *Ch. fibrosa* ssp. *flaccida* is the same as that of the branchlets; in this material the number of stipulodes is 2 × that of the branchlets. The branchlets of *Ch. fibrosa* are entirely ecorticate, the second articulation of the branchlets of this material is sometimes corticate. As, however, most branches are entirely ecorticate, this specimen belongs probably to *Ch. hydropitys* f. *gymnophylla* A. Braun.

3. **Chara zeylanica** Willdenow

H. and J. Groves 1911, p. 40; Zaneveld 1940, p. 203; Zaneveld 1941, p. 142.

Monoecious. Cortication of the stem triplostichous, primary cortical cell-series equally developed as the secondary. Spine-cells numerous. Stipulodes in a double row. Branchlets 8—14 in a whorl. composed of 6—15 articulations, the short lowest and usually 1—3 terminal articulations ecorticate. A very variable species.

Distribution: Common throughout all tropical regions.

Localities: Margarita 13, 18; Bonaire 379a, 379b; Klein Bonaire 63d, 63c; Curaçao 70, 75a, 76Aa, 89, 390, 396, 397b; Aruba 99; Paraguaná 108, 109; La Goajira 114; Barbuda 667, 674; St. Martin 678; Anguilla 544; New Providence (Bahamas) 548 (50—12460 mg Cl/l).

f. **guatemalensis** (Nordstedt) Zaneveld 1941, p. 144. — *Chara gymnopus* A. Braun ssp. *guatemalensis* Nordstedt 1888, p. 193.

Branchlets always entirely ecorticate, consisting of 5—8 articulations. Anterior pair of bract-cells longer than the oogonium, lateral and posterior bract-cells shorter.

Distribution: Guatemala, Honduras, Antilles (Curaçao, St. Croix).

Localities: Curaçao 76Aa, St. Croix (Diamond pool, fresh water, near Rum Factory, Wagenaar Hummelinck 13-1-1955) (240 mg Cl/l).

f. **armata** (Meyen) Zaneveld 1940, p. 200. — *Chara armata* Meyen 1835, p. 31; Kützing 1857, p. 30.

Plants compact, internodes $^2/_3$ × as long as branchlets, full-grown branchlets 3—5 mm long. Stem-hairs very long; usually as long as the stem-diam. Branchlets 8—12 in a whorl, composed of 6—11 articulations, of which the lowest one and the ultimate one are corticulate (sometimes all of them). The lowest articulations are often not shortened.

Distribution: India, Indonesia (Sumatra, Java), Philippine Islands (Luzon), New Caledonia, Antilles (Klein Bonaire).

Localities: Klein Bonaire 63c, 63d (12160—12410 mg Cl/l).

f. **trichacantha** (A. Braun) H. et J. Groves 1911, p. 41; Zaneveld 1941, p. 143 — *Chara gymnopus* A. Braun var. *trichacantha* A. Braun 1882, p. 192.

Plants rather large and slender, internodes about 1—3 × as long as the branchlets; branchlets 13—20 mm long. Spine cells long, usually as long as the stem-diameter. Branchlets 11—13, composed of 8—10 articulations of which the first and the last are ecorticate. Anterior bract-cells about as long as the oogonium, posterior ones about half as long. Oogonia produced at the 1—3rd branchlet-node.

Distribution: U.S.A. (Key West, Texas, South Carolina), Bahamas, Antilles (Bonaire, St. Martin).

Localities: Bonaire 379b; Klein Bonaire 63c; St. Martin 530a, 678; New Providence 548 (17—12160 mg Cl/l).

f. **michauxii** (A. Braun) H. et J. Groves 1911, p. 42; Zaneveld 1941, p. 144—145.

Plants large. Anterior and lateral pairs of bract-cells short, shorter than the ripe oogonium, posterior bract-cells papilliform. Branchlets 9—14, composed of 9—12 articulations of which the lowest and ultimate ones are ecorticate. Stem hairs few, very short. Oogonia not produced at the lowest node.

Distribution: Haiti, U.S.A., Venezuela, Cuba, Jamaica, St. Domingo, Antilles (Margarita, Curaçao).

Localities: Margarita 13, Curaçao 390, Paraguaná 108 (50—725 mg Cl/l).

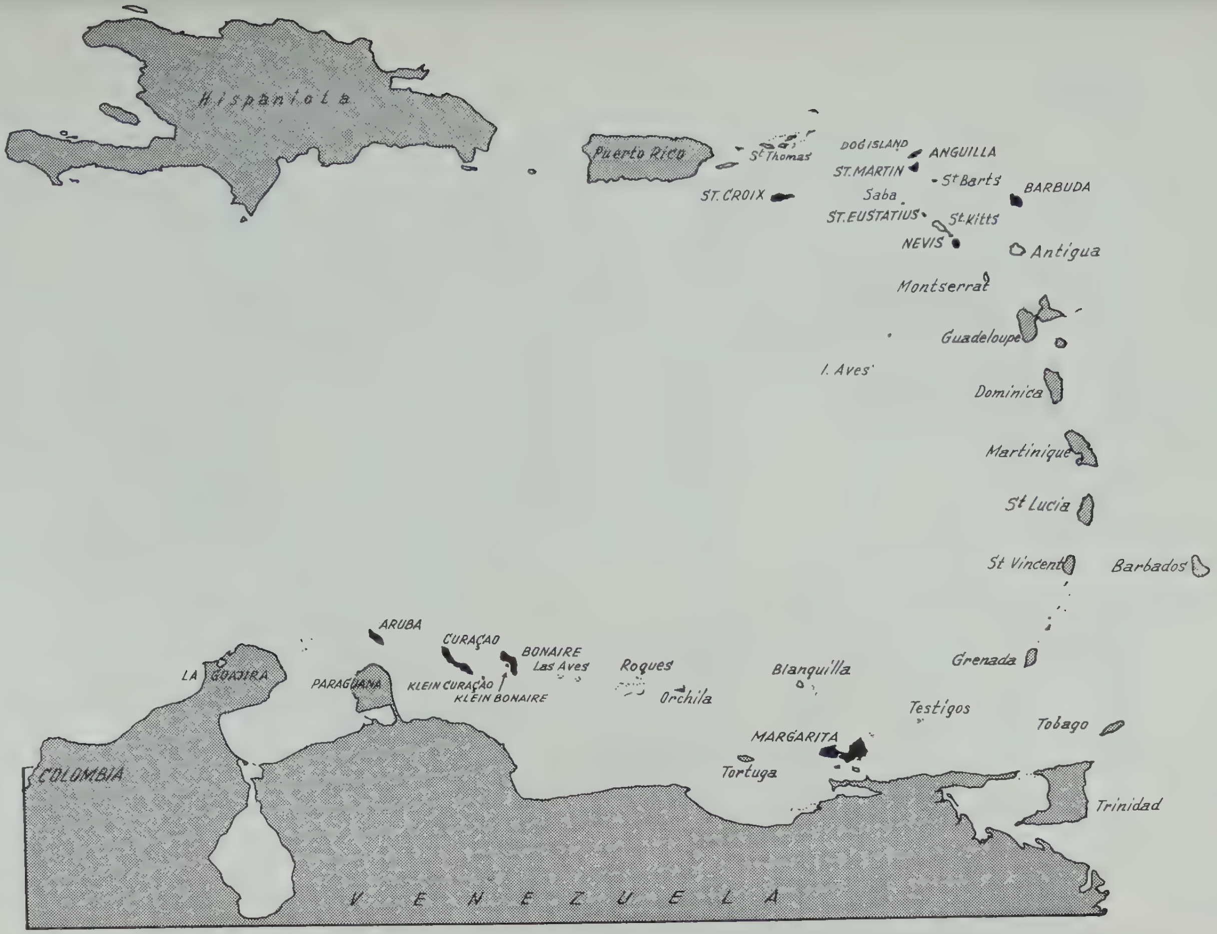

Fig. 12. *Netherlands Antilles*, with neighbouring islands and part of the South American continent.

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NOTE ON LECIDELLA CARPATHICA KÖRB.

by

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(Rijksherbarium, Leiden)

(Issued May 1st, 1959)

When revising the indigenous species of the genus *Lecidea,* I came across a case in which Körber's *Lecidella carpathica* appeared to have been misunderstood. As the original description is insufficient for a good understanding of what its author had in hands, a redescription of the type specimen would not seem out of place.

For the supply of some material for comparison my thanks are due to Dr R. Santesson, Uppsala.

Lecidea carpathica (Körb.) Szat. in Bot. Közl. **15**: 27. 1916. — *Lecidella carpathica* Körb., Par. lich. 212. 1865. — Type: "*Lecidella carpathica* Kbr., Ungarn (Hazsl.)" in Körber, Typenherbar (L 910. 188 — 726; selected).

Lecidea latypiza Nyl. sensu H. Magn. in Medd. Göteborgs bot. Trädg. **16**: 128. 1945.

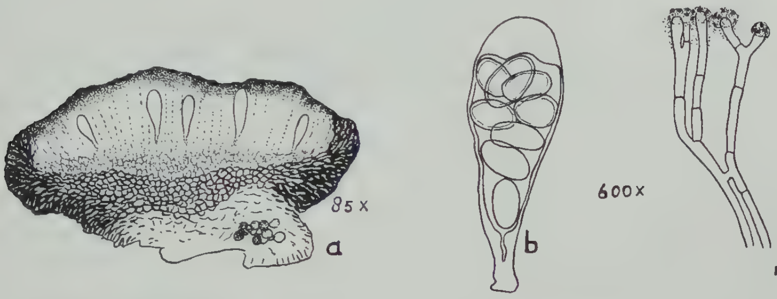
Forma **carpathica**. — Type: as above.

Exsiccati. — Arnold, Lich. monac. exs. 113 (*Lecidea latypea*; L); Hepp, Flecht. Europ. 133 (*Biatora sabuletorum β coniops*; L); Körber, Lich. sel. germ. 251 (*Lecidella carpathica*; L).

Thallus coarsely granular-verrucose, whitish, K + yellow, C —, medulla J —. Apothecia gregarious, either solitary and 0.3—0.5 mm across, or confluent and up to 0.9 mm across, adnate, plane, marginate, becoming somewhat convex with receding margin, black.

Excipulum paraplectenchymatous and fulvous in median part of apothecium, about 50 μ, scleroplectenchymatous and more or less dark blue-green towards the sides, median part K + bright orange-brown. Hymenium colourless or bluish green upwards, J + dark blue, about 80 μ. Epithecium blue-green, K —. Subhymenium subparaplectenchymatous, yellow-brown. Asci clavate, 8-spored, 55—71 × 18—20 μ. Spores 1—2-seriate to clustered, 1-celled, ellipsoid, yellowish, 11.8—13.8 × 5.9—6.5 μ. Paraphyses septate, somewhat branched especially in upper half, with infrequent anastomoses, easily loosened in KOH, about 2 μ, apical cells irregularly clavate from encrusted matter, up to 4 μ.

Observations. On the strength of his examination of a specimen of *Lecidella carpathica* at Uppsala, Dr Magnusson decided that this species is identical with *Lecidea goniophila* Nyl., and reduced it to the synonymy of the latter. He had no other choice indeed, for communication with other countries at that time, 1944, was cut off. Unfortunately, however, the specimen which Körber had sent to Uppsala is not identical with his type. I have seen the material, through the courtesy of Dr Santesson, and I fully agree that it is nothing but *L. goniophila.*



Lecidella carpathica Körb., type; a. partly diagrammatic section of apothecium; b. ascus; c. upper half of paraphyses (in KOH).

As to the type specimen of *Lecidella carpathica,* it is well in accordance with *Lecidea latypiza* Nyl. as described by Magnusson (l. c.: 128), as well as with material identified by this author: Sweden, Närike, St. Mellösa, Ytterby; 1890; P. J. Hellbom (UPS). Whether it also agrees with the species as conceived by Nylander I am as yet unable to say. I have not seen Nylander's type, whilst there is no indication that Magnusson has seen it. The latter described the hypothecium (called subhymenium in the present paper) as being concolorous with the brownish fulvous median part of the excipulum, whereas Vainio (1934: 255) found the hypothecium "pallidum." It is on account of this discrepancy that I think it best for the time being to cite the synonym as *L. latypiza* Nyl. sensu H. Magn.

Forma **distrata** (Arn.) Maas G., comb. n. — *Lecidea distrata* Arn. in Verh. zool.-bot. Ges. Wien **37** (Abh.): 100. 1887; not Nyl. apud Cromb. in J. Linn. Soc., London (Bot.) **15**: 179. 1876 = *Buellia distrata* (Nyl.) Zahlbr., Cat. Lich. un. **7**: 357. 1931. — *Lecidea distratula* Zahlbr., Cat. Lich. un. **3**: 566. 1925 (name change). — *Lecidea latypiza* f. *distrata* (Arn.) H. Magn. in Medd. Göteborgs bot. Trädg. **16**: 129. 1945. — Type distribution: Arnold, Lich. exs. 941 b (*Lecidea distrata;* selected).

Exsiccati. — Arnold, Lich. exs. 941a (*Lecidea distrata*; L).
Description. — See Magnusson, l. c.

Observation. Both Zahlbruckner and Magnusson indicated 1885 as the first date of publication of *L. distrata,* as also did Arnold himself. Here (Arnold, 1885: 239), however, '*distrata*' appears as a subspecies and as a provisional name at that, with a reference to "Arn. 941a, b." These exsiccati which were issued in 1883 have "*Lecidea distrata*" printed on their labels, but since no description was supplied, the name is a nomen nudum.

Forma **laevigata** (H. Magn.) Maas G., comb. n. — *Lecidea latypiza* f. *laevigata* H. Magn. in Medd. Göteborgs bot. Trädg. **16**: 129. 1945. — Type distribution: Arnold, Lich. monac. exs. 176 (*Lecidea latypea*; selected).

Exsiccati. — Arnold, Lich. monac. exs. 175 (*Lecidea latypea*; L); 279 (*Lecidea latypea*; L).

Description. — See Magnusson, l. c.

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REVIEW

C. LINNAEUS, Species Plantarum. Facsimile of the first edition, 1753. — Vol. 1, with an Introduction by W. T. Stearn; pp. xiv + 176 (Introduction) + 560 (Facsimile); 1957; price 50 s. — Vol. 2, with an Appendix by J. L. Heller and W. T. Stearn; pp. xvi + 640 (Facsimile) + 148 (Appendix); 1959; price 60 s. — Bernard Quaritch, Grafton Street, London, for the Ray Society.

The well-known Ray Society undertook the publication of this new facsimile of Linnaeus's most famous and still indispensable botanical work and had it reproduced photographically from an original copy in Linnaeus's library, later owned by Sir James Edward Smith. It represents the third facsimile edition of the work and, in spite of the earlier Berlin (1907) and Tokyo (1934) editions, which are no longer obtainable, it will certainly fill a real need, were it only to save copies of the rare and expensive original from wear and tear.

Although much has been written about Linnaeus and his numerous publications, the delightful frame provided by W. T. Stearn and J. L. Heller makes the new edition all the more valuable and useful, not only since the supplementary chapters enliven the book as a cultural product of its period but because the introduction and much of the appendix have been very ably written by a working taxonomist primarily concerned with Linnaeus's works for their relevance to modern botanical nomenclature, who has thoroughly studied history, method and bibliography and also, to some extent, the life and psychology of the author and the scientific attitudes of the period. Stearn has also aimed at avoidance of the misunderstanding and confusion, which follow from treating 18th century publications as if they were 20th century productions. Emphasis is laid on what may well be the most important conclusion for Linnaean typification in the whole work (cf. p. 97), viz. that within every main entry in *Species Plantarum* there is, or was at some stage of its development, an illustration or a specimen seen by Linnaeus and not simply a description by a pre-Linnaean author, the exceptions being definitions or descriptions by Van Royen, Gronovius, or Boissier de Sauvages, his disciples, so to speak, in the Linnaean method, whose work was therefore acceptable.

The alterations in terminology made by Linnaeus and his emphasis on floral and fruiting characters often ignored by earlier authors obliged him to look for these with his own eyes in illustrations and specimens, quite apart from the mental difficulty of dealing simply with words. This matter of the visual element in Linnaean concepts, which presumably has a connection with his aesthetic sensitivity (cf. Appendix p. 95), seems not previously to have been well understood, just as the importance of the phrase-name, the keystone of *Species Plantarum*, based on this element, has likewise not been much appreciated as giving a significant indication of his intent (p. 126).

The Introduction to Vol. I contains 18 chapters as well as a General Bibliography and an Index. Their contents are diversified and most of them have been written in a very lively style and provide delightful reading. Some topics are an epitomized biography, a survey of Linnaeus's major publications, essays on *Genera Plantarum* (and typification), *Hortus Cliffortianus, Amoenitates Academicae,* the authorship of Linnaean dissertations, the history of *Species Plantarum* in its many aspects, including sources, method, language, geographical names, typification, various editions, Linnaean herbaria (in London, Stockholm, Uppsala, Paris, and Oxford), and Linnaeus's species concept.

Rickett (in Bull. Torr. Bot. Club 85, 1959: 492) made an amusing reference to the inclusion of a chapter on the reception of *Species Plantarum* in England. Mr. Stearn informs me that the reason for this was that the Ray Society exists for the publication of learned works, primarily on the natural history of the British Isles, and secondarily of Europe, wherefore it seemed desirable to pay some regard to the Society's traditions in this way.

The Appendix is essentially an addition to the introduction and was placed at the end of Vol. II in view of the desirability of giving the two volumes approximately the same size. It contains Heller's very useful annotated list (60 pages) of authors and works quoted by Linnaeus as well as Stearn's notes on the 22 mostly little known illustrations, and on four supplementary Linnaean publications with facsimile pages, an Index to the Appendix, and another one to taxa mentioned in the two Volumes. A feature of this index is the indication, by italic type and signs, of species which have been chosen by various authors as the lectotypes of Linnaean genera. The attention of those interested in the history of taxa is called to a note (on p. 93—96) on natural and artificial systems of classification and to Artedi's part (p. 74) in the creation of Linnaean method.

It is pleasant to note the many references to Dutch activities and publications in this work, to read how Linnaeus enjoyed in Holland "the material prosperity" an "made good use of the fine collections resulting from the 'Golden Century' of the Dutch Netherlands" (p. 6), that "Linnaeus's most fruitful years as an author were those spent in Holland" (p. 9), to find emphasized "the generosity and unselfish co-operation of his Dutch friends" (p. 10) and to have tribute paid to Dutch cartography (p. 143) and printing (p. 75). Citations of publications by Boerman, Engel, Danser, Lotsy, Van Steenis, and De Wit also indicate that the work of Dutch scholars has been by no means neglected, while Swedish publications on Linnaeus and his time have been consulted to an extent unusual for a botanist who is neither Dutch nor Swedish.

The whole work is admirably produced and the fact that it has been published by a learned Society has undoubtedly exerted a favourable influence on the price, which, for a work like this, is unusually low. Unfortunately, printing errors in the Introduction are none to rare; these errata have, however, been corrected and additions inserted in the first pages of Vol. II. An obvious, not corrected one is 1954 for 1754 (p. 45, line 10). The paper by Stearn on "Botanical exploration to the time of Linnaeus" listed on p. 150 of the Introduction as 'ined.' has now been published in Proc. Linnean Soc. London 169: 173—196 (1958). In the Index of the Appendix (p. 111) under *Barleria Prionitis* the sign ‡ should be ǂ referring to Britton and Wilson and not to Britton and Brown.

These, however, are minor points and I think there is no doubt that this new edition of one of the most renowned botanical works of all time will, in its present form, not fail to raise new interests and to meet with an eager reception in many institutional and private libraries. It is certainly indispensable for all students of Linnaeus's works, his personality and his period.

H. J. LAM.

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to Vol. IX

compiled by

D. N. F. KIEHL

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1) Excluded is the article by C. van den Hoek (187—206).

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